United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

FEB 14 2017

In Reply Refer To:
01EWFW00-2015-F-0959

Daniel M. Mathis
U.S. Department of Transportation
Federal Highway Administration
711 Capitol Way South, Suite 501
Olympia, Washington 98501-1284

Dear Mr. Mathis:

This letter transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) addressing the proposed Index-Galena Road Relocation project located on and adjacent to the North Fork Skykomish River in Snohomish County, Washington, and its effects on the bull trout (*Salvelinus confluentus*), marbled murrelet (*Brachyramphus marmoratus*), and designated bull trout critical habitat. On September 11, 2015, we received your Biological Assessment (BA) providing information in support of a "may affect, likely to adversely affect" determination for the bull trout. On April 21, 2016, we received your BA amendment providing additional information, including revised "may affect, likely to adversely affect" determinations for the marbled murrelet and northern spotted owl. Formal consultation on the proposed action was conducted in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

The enclosed Opinion is based on information provided in the August 2015 BA, a site visit conducted on January 12, 2016, the April 2016 BA amendment, September 2016 Environmental Assessment, telephone conversations, and other sources of information cited in the Opinion. A complete record of this consultation is on file at the Service's Washington Fish and Wildlife Office in Lacey, Washington.

The enclosed document includes a section separate from the Opinion that addresses your concurrence request. We included a concurrence for the northern spotted owl (*Strix occidentalis caurina*). The rationale for this determination is included in the concurrence section.

The Federal Highway Administration has made "no effect" determinations for additional species and critical habitat that are known to occur in Snohomish County. Your determinations that the action will have no effect on these listed species and critical habitat rest with the federal action agency. The Service has no regulatory or statutory authority for concurring with "no effect" determinations, and no consultation with the Service is required. We recommend that the federal action agency document their analyses and maintain that documentation in their project files.

If you have any questions regarding the enclosed Opinion, our response to your concurrence requests, or our shared responsibilities under the Endangered Species Act, please contact Ryan McReynolds at 360-753-6047, or Martha Jensen at 360-753-9000.

Sincerely,

for Eric V. Rickerson, State Supervisor
Washington Fish and Wildlife Office

Enclosure(s)

cc:
FHWA, Olympia, WA (J. Horton)
WSDOT, Olympia, WA (M. Vance)
Snohomish County, Everett, WA (I. Sato)
Snohomish County, Everett, WA (C. Ritz)
USFS, Wenatchee, WA (R. Vacirca)
USFS, Darrington, WA (P. Reed)

Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION

U.S. Fish and Wildlife Service Reference:
01EWFW00-2015-F-0959

Index-Galena Road Relocation Project

Snohomish County, Washington

Federal Action Agency:

Federal Highway Administration

Consultation Conducted By:

U.S. Fish and Wildlife Service
Washington Fish and Wildlife Office
Lacey, Washington

Eric V. Rickerson, State Supervisor
Washington Fish and Wildlife Office

14 February 2017
Date

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ACRONYMS AND ABBREVIATIONS

Act	Endangered Species Act of 1973, as amended (16 U.S.C. l531 *et seq.*)
BA	Biological Assessment
BMP	best management practice
CFR	Code of Federal Regulations
CMZ	channel migration zone
County	Snohomish County
dBA	A-weighted decibel level
dbh	diameter-at-breast-height
FHWA	Federal Highway Administration
FMO	foraging, migrating, and overwintering
FR	Federal Register
ft^2	square feet
km	kilometers
LOP	limited operating periods
LSR	Late Successional Reserve
MBSNF	Mt. Baker-Snoqualmie National Forest
mi^2	square mile
MP	milepost
mph	miles per hour
NMFS	National Marine Fisheries Service
NTU	nephelometric turbidity units
OHWM	Ordinary High Water Mark
Opinion	Biological Opinion
PBF	Physical or Biological Feature
PCE	Primary Constituent Element
RM	river mile
RPM	Reasonable and Prudent Measures
RUIP	Recovery Unit Implementation Plan
Service	U.S. Fish and Wildlife Service
SPCC	Spill Prevention, Control, and Countermeasures
USFS	U.S. Forest Service
WDFW	Washington State Department of Fish and Wildlife
WSDOT	Washington State Department of Transportation

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INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) based on our review of the proposed Index-Galena Road Relocation project located on and adjacent to the North Fork Skykomish River in Snohomish County, Washington, and its effects on the bull trout (*Salvelinus confluentus*), marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), and designated bull trout critical habitat, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*)(Act).

On September 11, 2015, we received a Biological Assessment (BA) from the Federal Highway Administration (FHWA) providing information in support of a "may affect, likely to adversely affect" determination for the bull trout. On April 21, 2016, we received a BA amendment providing additional information, including revised "may affect, likely to adversely affect" determinations for the marbled murrelet and northern spotted owl. This Opinion is based on information provided in the August 2015 BA, a site visit conducted on January 12, 2016, the April 2016 BA amendment, September 2016 Environmental Assessment, telephone conversations, and other sources of information cited in the Opinion. A complete record of this consultation is on file at the Service's Washington Fish and Wildlife Office in Lacey, Washington.

CONSULTATION HISTORY

The following is a summary of important events associated with this consultation:

- A BA was received from the FHWA on September 11, 2015.
- A site visit was conducted on January 12, 2016, with participation from the Washington State Department of Transportation – Highways and Local Programs Office (WSDOT) and Snohomish County Public Works (County).
- A BA amendment was received from the FHWA on April 21, 2016. Formal consultation was initiated on April 21, 2016.
- A copy of the draft Opinion was provided to the FHWA, WSDOT, and County on December 1, 2016.
- Comments for the draft Opinion were received on December 8 and 29, 2016.

CONCURRENCE FOR THE NORTHERN SPOTTED OWL

On April 21, 2016, we received a BA amendment providing information in support of a "may affect, likely to adversely affect" determination for the northern spotted owl. However, upon the Service's full review of the environmental baseline, the foreseeable direct and indirect effects of the proposed action, the effects of interrelated and interdependent actions, and the cumulative effects that are reasonably certain to occur in the action area, we conclude that the proposed action "may affect" but is "not likely to adversely affect" the northern spotted owl, its habitat, and prey resources. This concurrence section provides the Service's rationale for concurring with a "may affect, not likely to adversely affect" determination for the northern spotted owl.

The FHWA, WSDOT, and County Public Works propose to relocate an approximately one half-mile long (0.5 mile) section of the Index-Galena Road. The proposed project will shift the existing roadway alignment to the south and establish a relocated roadway section upslope from the existing damaged roadway. The new alignment will require constructing a series of moderate to deep cuts and fills to provide a grade suitable for motor vehicles. Use of low-volume roadway design standards and guardrail sections will reduce the required roadway width.

Construction of the new alignment and proposed features will require substantial clearing and grading. The project area is estimated at 11.5 acres (FHWA, WSDOT, and Snohomish County 2016, p. 15) to 12.2 acres (Snohomish County Public Works 2015, p. 9). The clearing limits along the new roadway alignment will be logged. Between 8.3 acres (FHWA, WSDOT, and Snohomish County 2016, p. 15) and 8.9 acres (Snohomish County Public Works 2015, p.10) will be restored at project completion with native plantings.

Construction of the new roadway section will require removing large rock obstructions from at least 550 linear ft of the alignment (Snohomish County Public Works 2015, p. 9; Snohomish County Public Works 2016, pp. 1-4). Conventional earth moving equipment will be used in combination with hydraulic hammers (or hoe rams), and rock drilling and blasting to remove these large rock obstructions as they are encountered and construction progresses along the new alignment. A typical day removing large rock obstructions will include two or more hours of pre-drilling, followed by one or two controlled blasts, and two or more hours of additional work using hydraulic hammers and excavators (Snohomish County Public Works 2016, p. 1).

The FHWA, WSDOT, and County have proposed conservation measures to avoid and reduce impacts during construction (Snohomish County Public Works 2015, pp. 10, 13, 14; FHWA, WSDOT, and Snohomish County 2016, pp. 49, 50, 54, 55, 59, 60, 67-69). These conservation measures include the following, which we expect will avoid and reduce exposures and effects to the northern spotted owl:

- Between April 1 and September 23, all work will start 2 hours after sunrise and stop 2 hours before sunset.

- The County will monitor replanted areas for 10 years to ensure mitigation success.

The terrestrial boundaries of the action area were defined based on the extent of temporary sound and visual disturbance that will result during construction. The Service conducted an independent analysis of in-air sound generation and attenuation using conservative assumptions. The Service has determined that temporary increased sound levels associated with routine construction activities are likely to exceed ambient, background sound levels to a distance of approximately 2,000 ft. However, sound levels resulting from blasting operations will attenuate to 70 dBA (A-weighted decibels referenced to 20 micropascals) at a distance of approximately 1.5 miles, and to 92 dBA at a distance of approximately 0.2 mile. Based on the elevated sound levels, the terrestrial boundaries of the action area extend to a distance of at least 1.5 miles.

Construction of the proposed project will result in temporary increases in sound and visual disturbance for the duration of two or three construction seasons (April through October). If northern spotted owls nest, roost, forage, or disperse in the action area they may experience temporary elevated levels of disturbance.

The surrounding landscape includes both deciduous dominated and mixed coniferous-deciduous forest. Within the project area and limits of construction these forested habitats consist mostly of mixed second growth stands located on rugged, steep, northwest-facing slopes. The closest designated late-successional reserves (LSRs) are located approximately one-half (0.5) mile to the southeast where mature forest can be found at higher elevations (Snohomish County Public Works 2015b, p. 22).

Observations made in the field on January 12, 2016, confirm that the second growth stands located within the project area do not provide suitable nesting, roosting, or foraging habitat for the northern spotted owl. We conducted a field reconnaissance of the proposed right-of-way and surrounding forested habitats. These stands do exhibit high canopy closure (>70 percent) at some locations. However, trees are mostly less than 30 inches in diameter-at-breast-height (dbh). A multi-storied canopy, large overstory trees, broken-topped trees, large snags, large accumulations of fallen trees, and large cavities suitable for northern spotted owl nest sites are all generally absent. These stands do provide suitable northern spotted owl dispersal habitat.

Two historic northern spotted owl activity centers, and portions of three territories, are located within 4 miles of the project area: Barclay Creek (Pair or Reproductive, 1989; Last Status - Pair, 1992); Silver Creek (Pair or Reproductive, 1984; Last Status - Single, 1989); and, Trout Creek (Resident Territorial Single, 1987; Last Status - Single, 1987). No protocol surveys have been completed in the action area during the last 20 years. The nearest designated critical habitat for the northern spotted owl is located to the southeast at a distance of at least 2,000 ft.

In the absence of reliable current survey data to describe occupancy, we used available rangewide maps of nesting and roosting habitat produced by MaxEnt species distribution modeling (with 2012 aerial imagery) to predict landscape-scale patterns of northern spotted owl habitat suitability and distribution (Davis et al. 2016). A coarse-scaled spatial analysis of these data and model outputs suggests that the action area, extending to a distance of approximately 1.5 miles, is approximately 6,665 acres in size and contains approximately 2,332 acres of suitable to highly suitable northern spotted owl habitat. These patches of suitable habitat are fragmented and discontinuous (Figure 1). These suitable habitats are located upslope, across the valley, and higher on the valley walls than the project area. This same analysis suggests that of the approximately 488 acres (total) located within 0.25 mile of the project corridor, only 26 acres represent suitable to highly suitable northern spotted owl habitat (Figure 2).

The Service concludes it is extremely unlikely that northern spotted owls nest, roost, or forage within 0.25 mile of the project corridor. Suitable habitats are fragmented and discontinuous. Given the landscape context and the absence of large patches of suitable or high quality habitat, it is extremely unlikely that northern spotted owls nest, roost, or forage within 0.25 mile of the project corridor. It is possible that transient northern spotted owls dispersing through the landscape may occasionally pass through the action area.

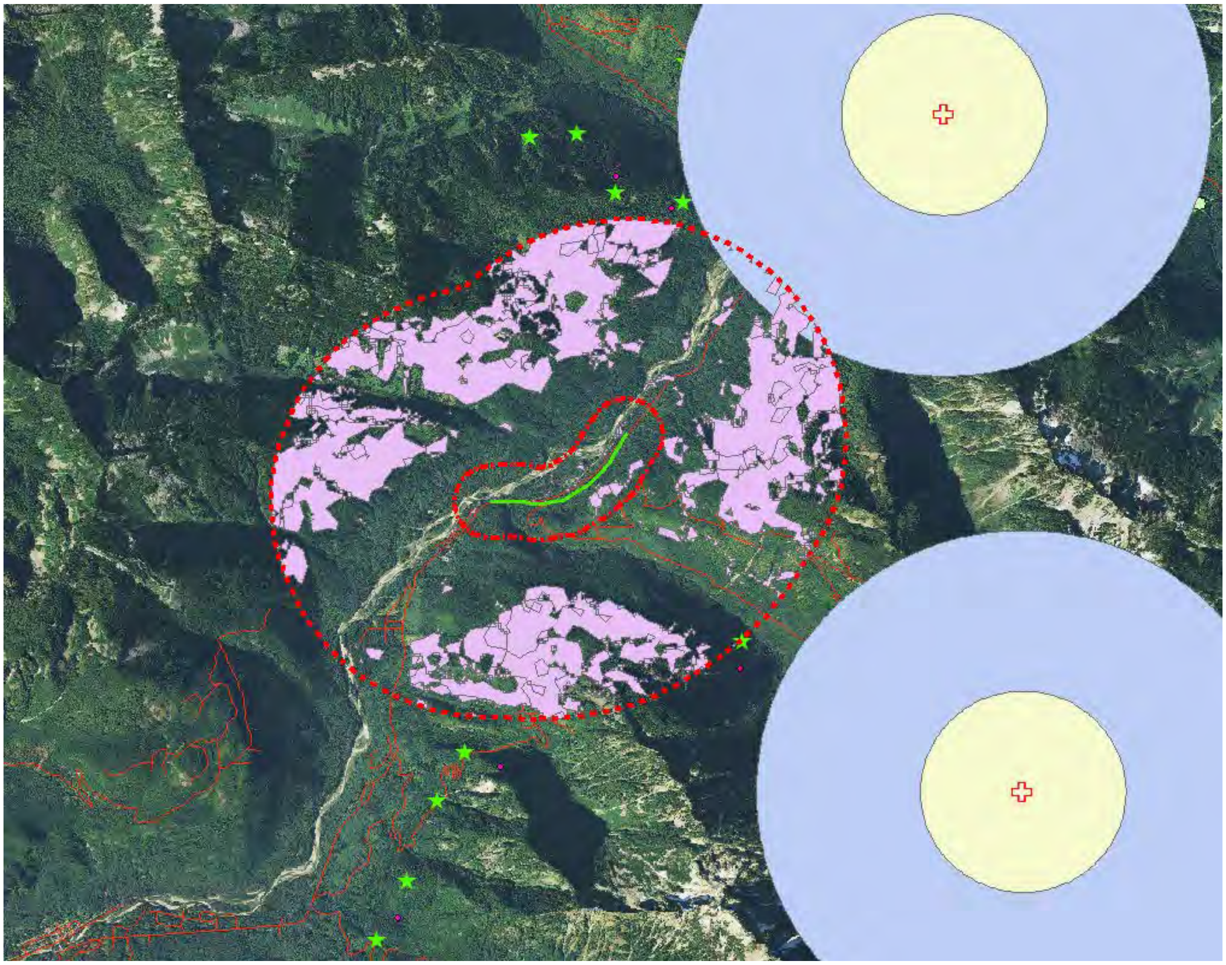

Figure 1. Screenshot depicting northern spotted owl habitat suitability data, historic activity centers, and territories.

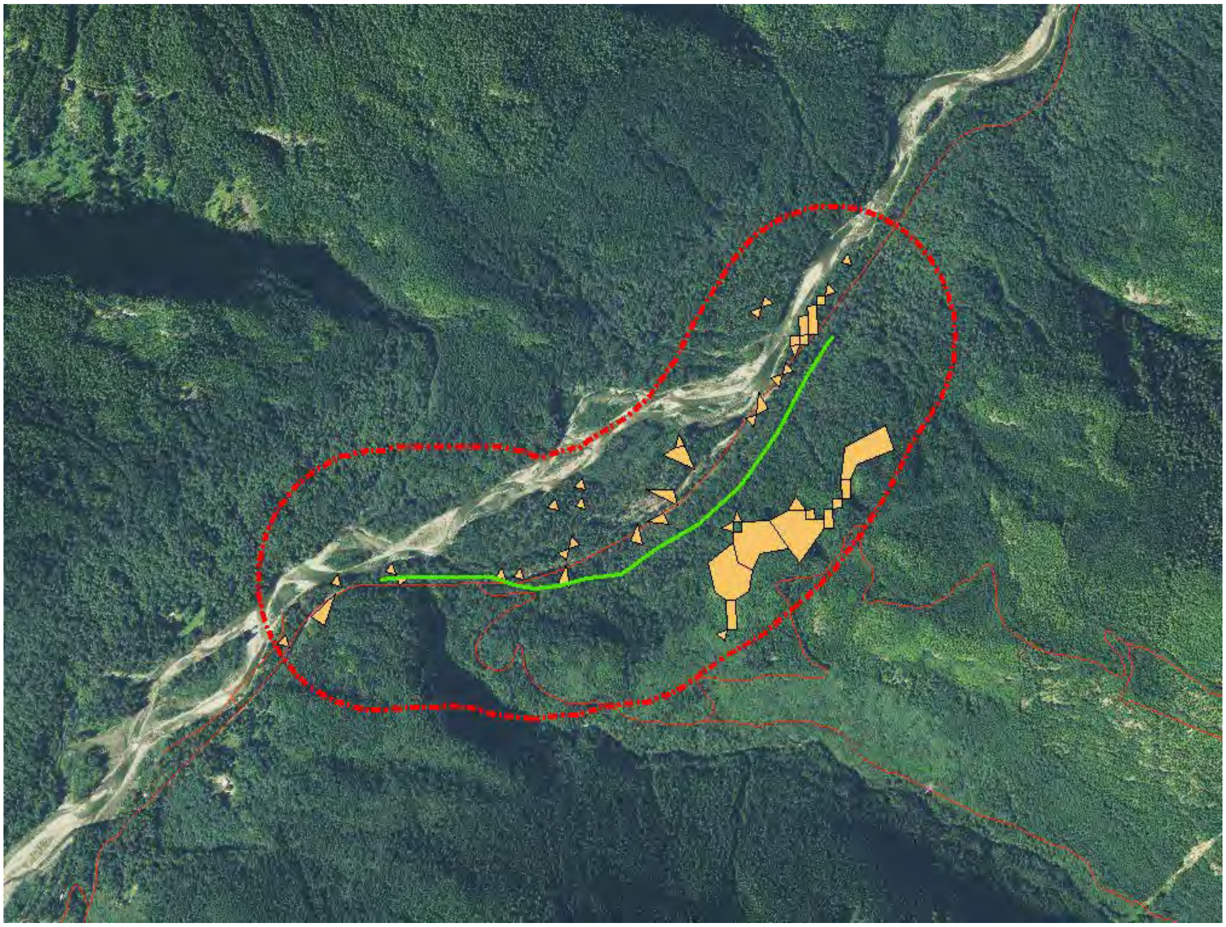

Figure 2. Screenshot depicting habitat suitability data, including small patches of potential habitat within 0.25 mile (approximately 26 acres).

Transient northern spotted owls dispersing through the action area may experience temporary elevated levels of disturbance associated with blasting operations. However, these potential exposures to elevated sound levels will be infrequent, will occur during daylight hours only, and are unlikely to elicit anything more than a mild behavioral response. The Service concludes that the proposed action and proposed construction activities will have no foreseeable adverse effects to nesting or roosting northern spotted owls. Foreseeable effects to northern spotted owls that potentially forage or disperse within 1.5 miles of the project corridor will be insignificant.

It is extremely unlikely that northern spotted owls currently use stands located within 0.25 mile of the project area for nesting, roosting, foraging, or dispersal. The Service concludes it is extremely unlikely that northern spotted owls will be exposed to increased sound levels associated with routine construction activities, or to the acutely high sound levels generated in close proximity to proposed blasting operations (e.g., greater than 92 dBA). Any exposures to northern spotted owls that forage or disperse in the action area will be infrequent, will occur during daylight hours only, and are unlikely to elicit anything more than a mild behavioral response. Foreseeable effects to northern spotted owls that potentially forage or disperse in the action area will be insignificant.

The proposed action will have no foreseeable adverse effects to northern spotted owls, their prey base, or habitat. With successful implementation of the agreed-upon conservation measures, it is extremely unlikely that the proposed action or proposed construction activities will affect nest success or result in measurable effects to the growth, health, or fitness of adult or juvenile northern spotted owls. With successful implementation of the agreed-upon conservation measures, the proposed action's temporary effects will not measurably or significantly disrupt normal northern spotted owl behaviors (i.e., the ability to successfully feed, move, and/or shelter), and are therefore considered insignificant.

The proposed action will not physically remove or functionally alter stands providing suitable northern spotted owl habitat, and will have no measurable effect on the northern spotted owl prey base or availability of food resources. The action will not result in changes in the use or function of the road infrastructure, and will not construct new points of access or increase traffic or visitor capacity. No future development proposals or other major actions are contingent or dependent upon the proposed action. The Service expects that no discernible changes in the rate or pattern of land use conversion will result, in whole or in part, from the action. We also expect that no discernible changes in long-term public use or management will result from the proposed action. Foreseeable long-term effects to the northern spotted owl, their prey base, and habitats will not be measurable, and are therefore considered insignificant.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

A federal action means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies in the United States or upon the high seas (50 CFR 402.02).

The Federal Highway Administration (FHWA), Washington State Department of Transportation – Highways and Local Programs Office (WSDOT), and Snohomish County Public Works (County) propose to relocate an approximately one half-mile (0.5 mile) section of Index-Galena Road that lies within the channel migration zone (CMZ) of the North Fork Skykomish River and was substantially damaged by a major flood event during November 2006. Extensive portions of the roadway between milepost (MP) 6.4 and 6.9 were eroded and lost during the flood event. The North Fork Skykomish River formed a new, left-bank side channel to the mainstem, occupied portions of the road alignment, and forced road closures that have remained in place for more than nine years. The damaged roadway sections between MP 6.4 and 6.9 lie within both the CMZ and 100-year floodplain.

Index-Galena road is a paved, two-lane, rural road that extends in a northeast direction from the town of Index, Washington, and travels a distance of approximately 14 miles within the Mt. Baker-Snoqualmie National Forest (MBSNF), before intersecting with Forest Road 65 (or Beckler River Road). Most of the road alignment lies on U.S. Forest Service (USFS) land (i.e., a roadway right-of-way easement). Forest Road 65 travels in a southeast direction for a similar distance, including over Jack’s Pass, before reaching the town of Skykomish, Washington (Figures 3 and 4). Index-Galena Road has lane widths of 10 to 12 ft and shoulder widths of 1 to 6 ft; it has a posted speed limit of 35 miles per hour (mph).

Index-Galena Road is a direct and vital transportation link to the upper North Fork Skykomish River area, for owners of private residences and recreational properties, for users of the public lands and designated wild and scenic rivers located on these portions of the MBSNF, and for the USFS (FHWA, WSDOT, and Snohomish County 2016, pp. 3-7). Forest Road 65 over Jack’s Pass is a single-lane, unimproved gravel road with steep grades and switchbacks; it provides only seasonal access and does not safely accommodate longer vehicles (e.g., recreational vehicles, log trucks). Since the major flood event during November 2006, and subsequent closure of the severally damaged portions of Index-Galena Road, many users have been forced to take a more than 40-mile alternate route. Closure of Index-Galena Road has increased response times for emergency services responding to vehicle accidents, search and rescues, and fire management and suppression (FHWA, WSDOT, and Snohomish County 2016, pp. 3-7).

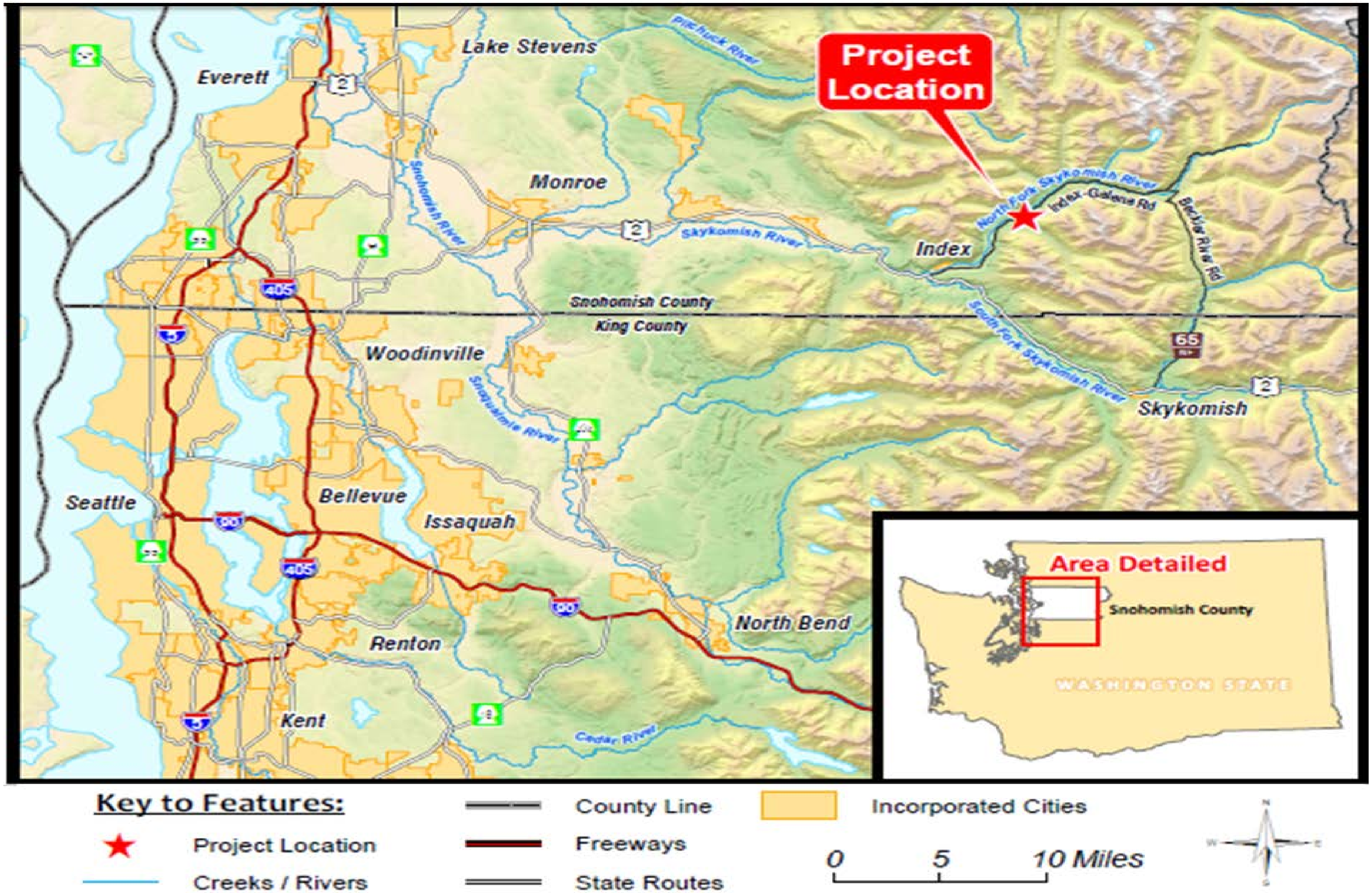

Figure 3. Vicinity map
(FHWA, WSDOT, and Snohomish County 2016)

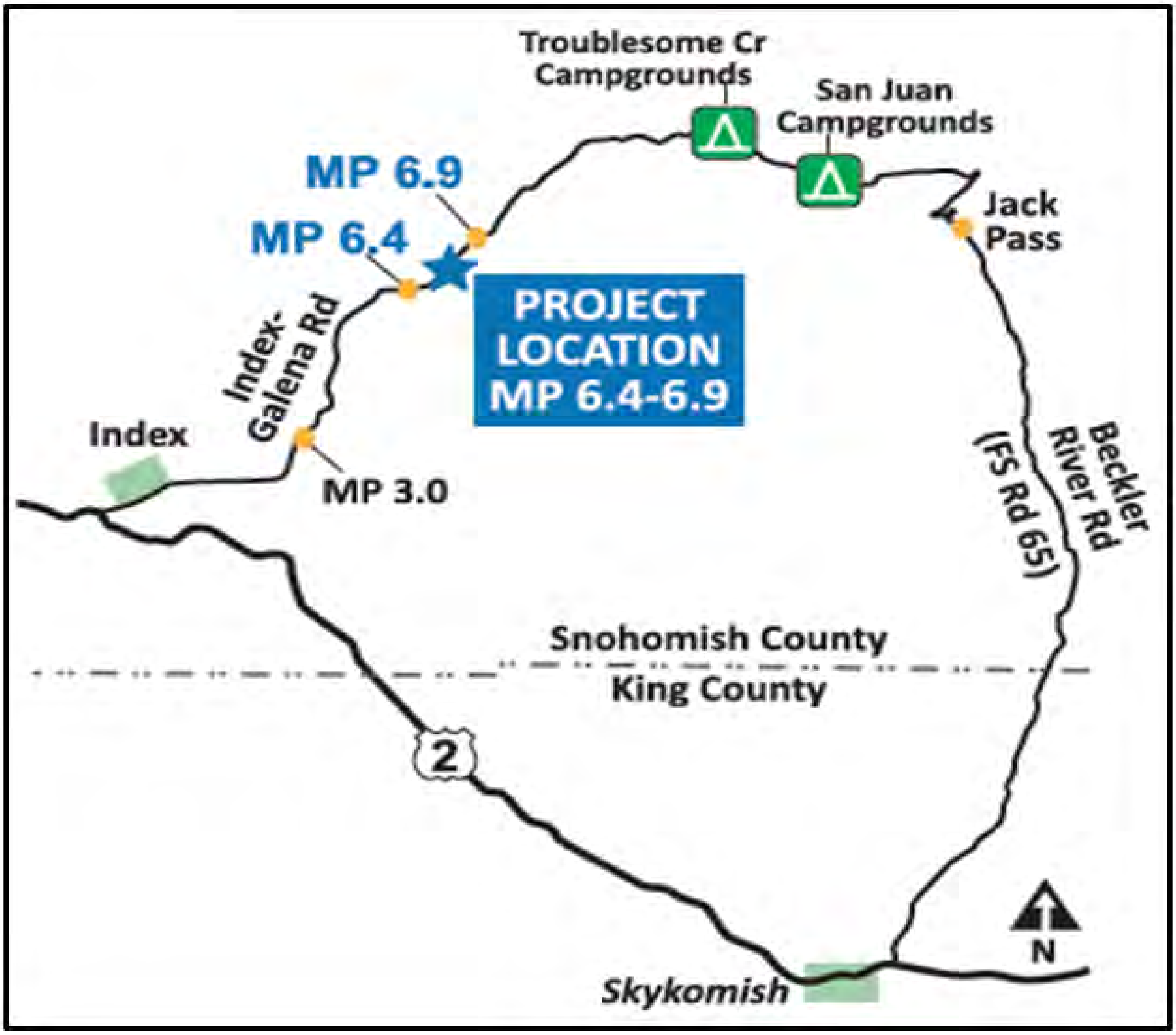

Figure 4. Vicinity map
(FHWA, WSDOT, and Snohomish County 2016)

The proposed project will shift the existing roadway alignment to the south and establish a relocated roadway section upslope from the existing damaged roadway. The new alignment will shift from the existing alignment approximately 200 ft east of Trout Creek Bridge #494. The new roadway alignment will ascend steep 9 percent grades in order to rise out of the CMZ and 100-year floodplain (FHWA, WSDOT, and Snohomish County 2016, p. 13). The initial climb will use a portion of the existing Trout Creek Road, a gravel road owned and maintained by the USFS. After an initial climb exceeding 9 percent grade, grades will moderate. The new alignment will require constructing a series of moderate to deep cuts (up to 13 ft) and fills (up to 22 ft) to provide a grade suitable for motor vehicles (Figure 5). Use of low-volume roadway design standards and guardrail sections will reduce the required roadway width to 22 ft (10-foot travel lanes and 1-foot shoulders). The posted speed limit will remain 35 mph (FHWA, WSDOT, and Snohomish County 2016, p. 15).

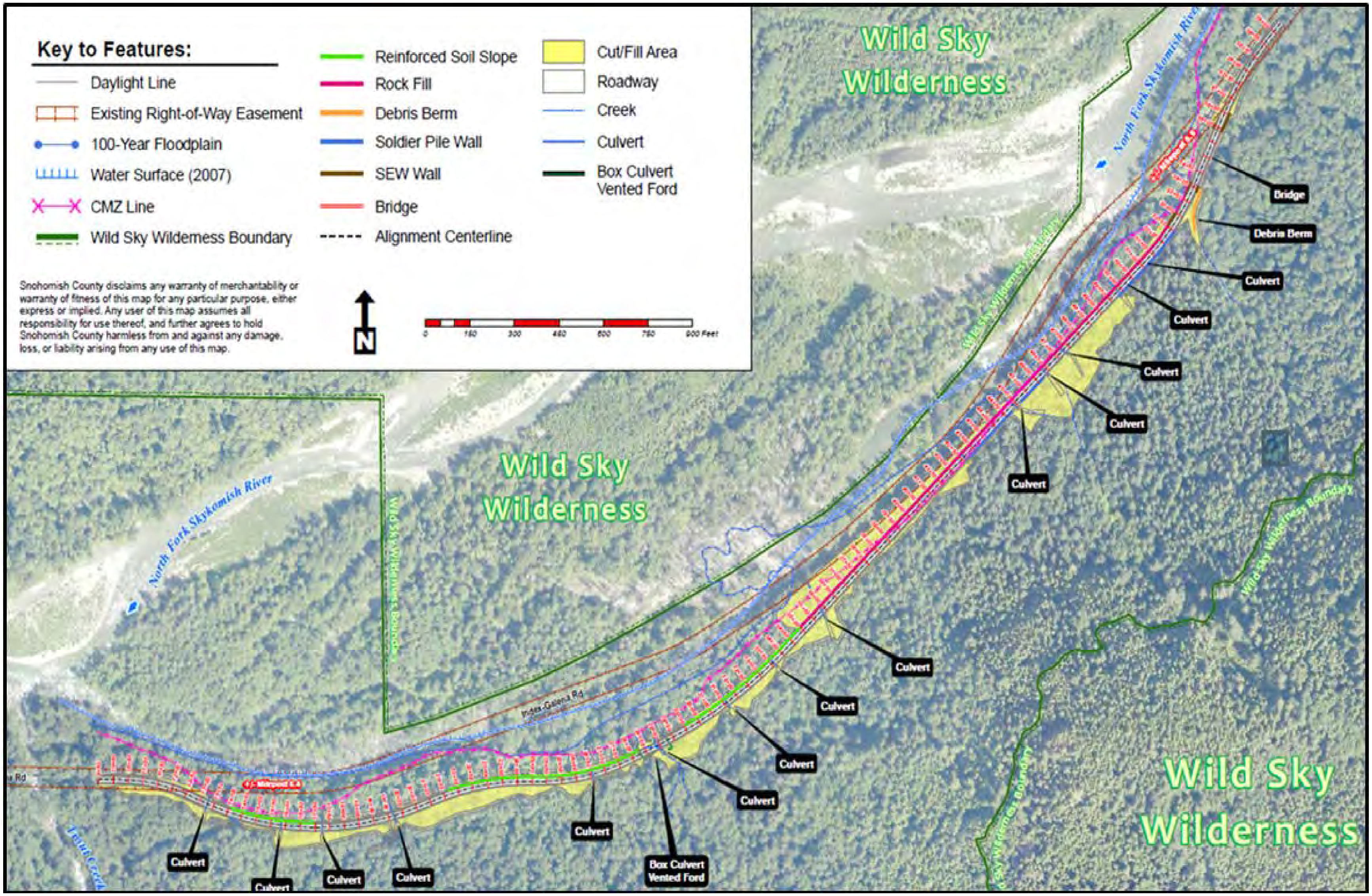

Figure 5. Index-Galena road relocation project (MP 6.4 to 6.9); existing and proposed alignments
(FHWA, WSDOT, and Snohomish County 2016, p. 5)

The proposed project will relocate most of the roadway section away from the left-bank side channel to the mainstem North Fork Skykomish River, away from the CMZ, and above the 100-year floodplain (FHWA, WSDOT, and Snohomish County 2016, p. 13). The new alignment will be approximately 0.85 mile in length; approximately 0.35 mile longer than the abandoned and removed roadway section in order to tie back into the existing road landward of the CMZ (Snohomish County Public Works 2015, p.6). The new alignment will begin its descent to the existing roadway near Station 36+00 and will tie back into the existing roadway at Station 60+00 (near MP 6.9). Constructed reinforced soil slopes, rock fill slopes, retaining walls (e.g., structural earth walls), and buried rock revetments (rock toe scour protection) will protect against slope instability along the new alignment (Figures 6, 7, and 8).

Portions of the new alignment, from Station 34+50 to 45+50 and from Station 48+00 to 54+00 (a total distance of approximately 1,700 linear ft or 0.32 mile), will require construction of buried rock revetments at the periphery of the CMZ (Figures 7 and 8). Close proximity to the CMZ when tying back into the existing alignment will require toe protection in the event of further lateral migration of the active channel (FHWA, WSDOT, and Snohomish County 2016, pp. 56, 57). A new 180-foot bridge with drilled-shaft foundations will be constructed at the stream crossing near Station 54+00 (Figure 8). The bridge will span wetlands and a seasonal stream located at the north end of the new alignment, will maintain and improve hydraulic connectivity with the North Fork Skykomish River, and preserve seasonal pool habitat and refugia created in part by backwatering during high flow events.

The new alignment and proposed features, including the buried rock revetments and 180-foot bridge, will reduce impediments to flood flow conveyance, and improve storage and attenuation of flood flows (FHWA, WSDOT, and Snohomish County 2016, p. 57). The proposed project is expected to result in no net rise in the water surface elevation during 100-year flood events.

Several non-fish bearing streams will be crossed by the new alignment (Figures 6, 7, and 8). These streams are narrow and flow down moderate to steep slopes before entering the North Fork Skykomish River floodplain. Most of the streams are intermittent and become dry or mostly dry by the end of summer (except for the stream at Station 28+98)(FHWA, WSDOT, and Snohomish County 2016, p. 51). New culverts installed along the alignment will not be designed for fish passage, but will be sized to accommodate and convey the 100-year (design-year) storm event and associated debris. At Station 28+98 a 12-foot vented ford box culvert will be installed (Table 1) (FHWA, WSDOT, and Snohomish County 2016, p. 53).

Once stabilized, side slopes will be covered with wood mulch, salvaged large wood (i.e., downed trees/logs), and forest duff to cover bare mineral soils. Large wood and rock protection will be placed and constructed at culvert outlets (FHWA, WSDOT, and Snohomish County 2016, p. 135). These measures will reduce erosion during and after construction, and are also meant to retain organic matter and promote revegetation.

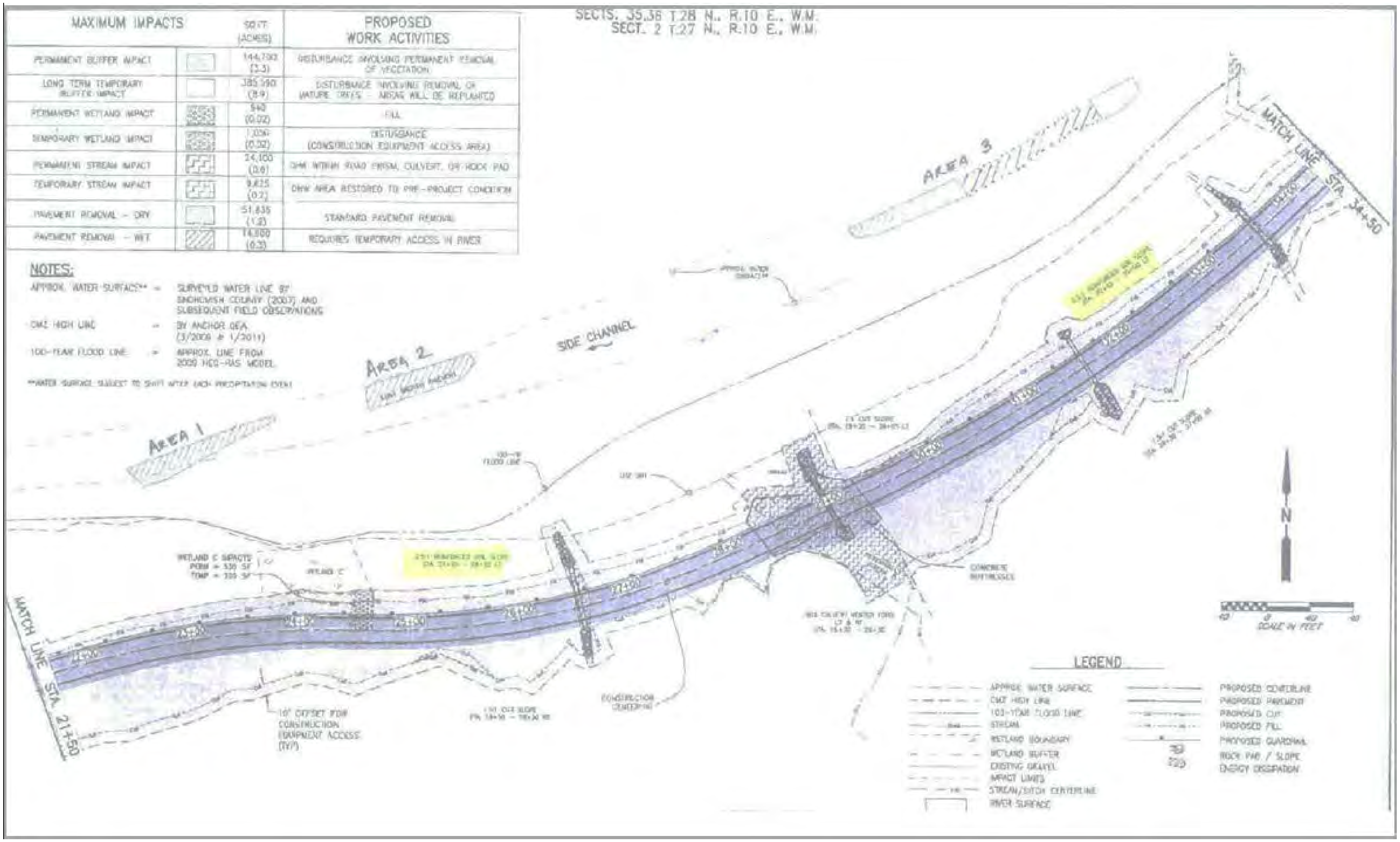

Figure 6. Roadway section plan sheet with details, including constructed reinforced soil slopes
(Snohomish County Public Works 2015, Appendix D)

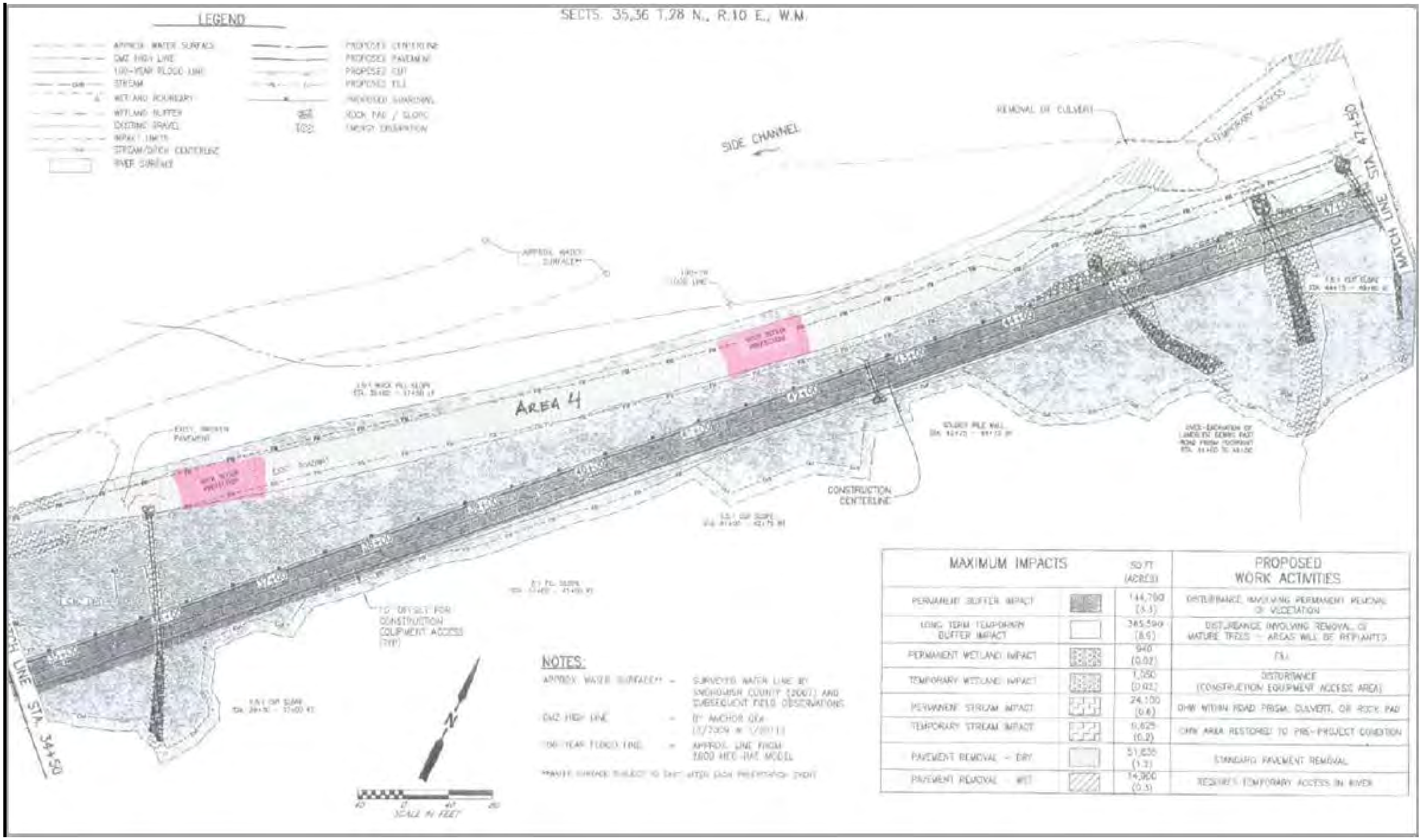

Figure 7. Roadway section plan sheet with details, including buried rock revetment
(Snohomish County Public Works 2015, Appendix D)

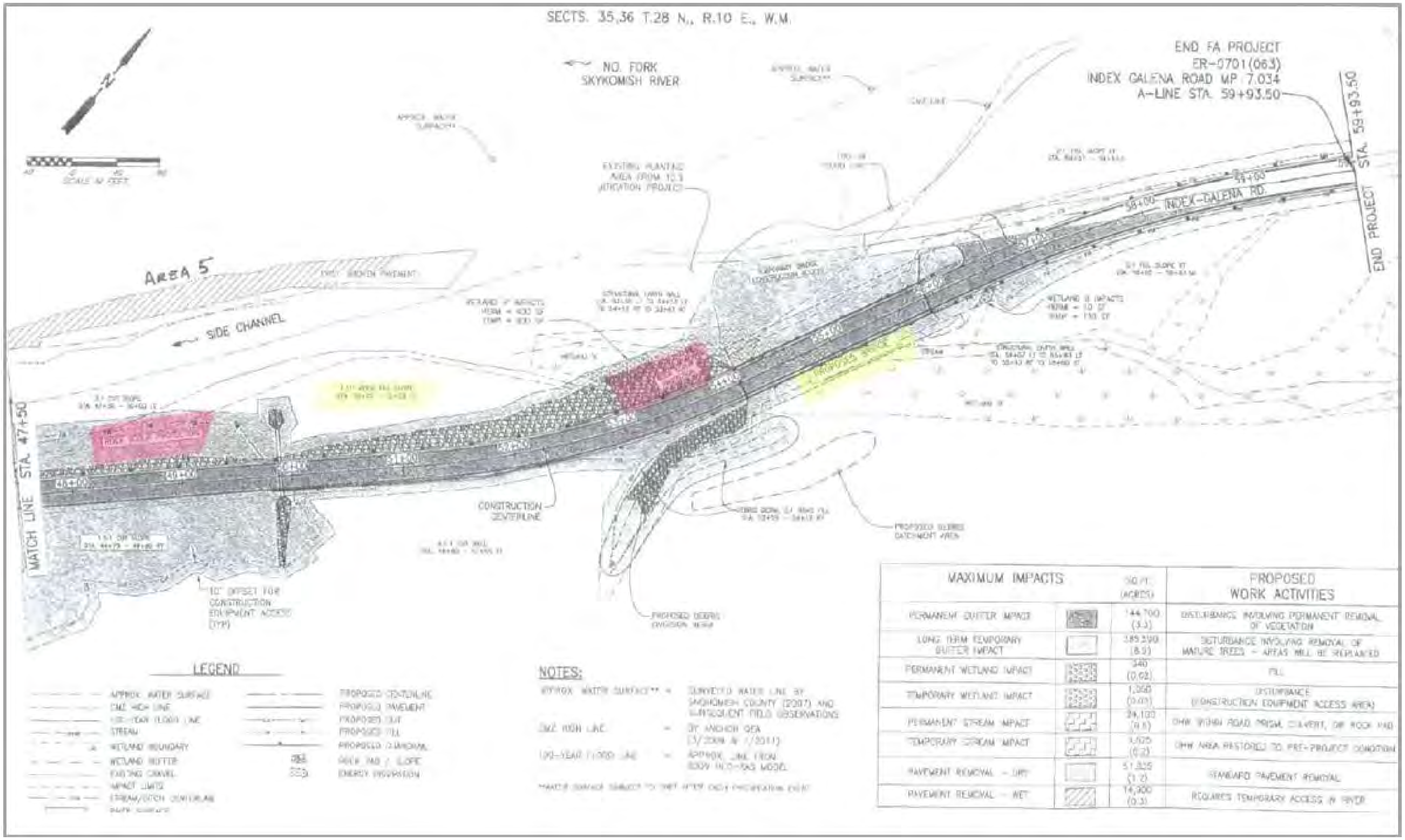

Figure 8. Roadway section plan sheet with details, including constructed rock fill slopes, buried rock revetment, and 180-foot bridge (Snohomish County Public Works 2015, Appendix D)

Table 1. Culvert locations and sizes

Culvert Number	Approximate Station Location	Culvert Length	Culvert Size	Conveyance Type
1	13+28	35	49" X 33" Arch	Drainage
2	15+87	39	36-inch diameter	Drainage
3	17+25	35	36-inch diameter	Drainage
4	19+70	56	48-inch diameter	Stream
5	26+57	50	36-inch diameter	Stream
6	28+98	35	12-foot vented ford box culvert	Stream
7	31+61	39	36-inch diameter	Drainage
8	33+61	44	48-inch diameter	Stream
9	35+90	50	36-inch diameter	Stream
10	44+84	52	48-inch diameter	Stream
11	46+39	34	64" X 43" Arch	Stream
12	47+25	30	48-inch diameter	Stream
13	50+20	42	36-inch diameter	Drainage
14	51+20	40	36-inch diameter	Drainage

(FHWA, WSDOT, and Snohomish County 2016, p. 53).

The proposed project will require a new right-of-way easement from the USFS. Existing damaged roadway sections along the old alignment will be decommissioned and removed, and the footprint restored where feasible with riparian plantings (FHWA, WSDOT, and Snohomish County 2016, p. 16). Once the decommissioned roadway sections are removed, soil decompaction and placement of organic materials, including salvaged topsoil and forest duff, will prepare the site for restoration. On-site riparian buffer mitigation, consisting of enhancement and restoration with native plantings, will restore a forested corridor adjacent to the North Fork Skykomish River (FHWA, WSDOT, and Snohomish County 2016, p. 16).

Unavoidable impacts to stream and riparian buffers will be compensated with on-site and off-site mitigation according to the requirements of the Snohomish County critical area regulations (FHWA, WSDOT, and Snohomish County 2016, p. 54). Nearly the entire project footprint is located within buffers, and therefore some amount of off-site compensatory mitigation will be required. Off-site mitigation will consist of credits purchased at an established mitigation bank (FHWA, WSDOT, and Snohomish County 2016, p. 54). WSDOT and the County will purchase credits at the Skykomish Habitat Mitigation Bank as compensation for permanent impacts and loss of approximately 3.3 acres of riparian buffer.

As part of decommissioning and removing the old alignment, roadway fill and debris will be removed from the left-bank side channel and CMZ where it is safe and practicable to do so (FHWA, WSDOT, and Snohomish County 2016, p. 16). Some of the debris has been substantially buried, or eroded by river flows and carried off-site. The removed asphalt and concrete debris may be recycled and reused when constructing the new alignment, or will be hauled off-site for disposal at an existing, permitted facility. Where possible, ballasted or anchored large wood will be installed to provide and improve channel roughness and instream habitat complexity; large wood will be installed along the waterward face of the buried rock revetments to “soften” the interface at the waterward edge of the rock toe scour protection (FHWA, WSDOT, and Snohomish County 2016, p. 60).

The proposed project will improve floodplain conditions by restoring floodplain connectivity that historically has been impeded by the existing roadway alignment (FHWA, WSDOT, and Snohomish County 2016, p. 57). The WSDOT and County also expect that moving the roadway further landward and removing roadway fill and debris from the CMZ will reduce future flood hazard risk. Floodplain connectivity will be restored to more than 200,000 square feet (ft^2) (4.6 acres) of floodplain (FHWA, WSDOT, and Snohomish County 2016, p. 57).

Construction of the proposed project could begin as early as 2018 if funds become available, the right-of-way easement is approved, and all permits and approvals are obtained. Construction will require a minimum of two construction seasons and could extend to three seasons depending on construction sequencing and contingencies (FHWA, WSDOT, and Snohomish County 2016, p. 57, pp. 17, 18). Due to the remote location of the project and expected difficult construction conditions, the WSDOT and County plan to complete all or nearly all of the work between April and October.

Construction Activities

Proposed construction activities will include (Snohomish County Public Works 2015, pp. 9-13):

- *Mobilization and Staging* – the existing roadway and other suitable, previously disturbed areas will be used to the fullest extent practicable.

- *Clearing and Removal of Vegetation* **–** construction of the new alignment and proposed features will require substantial clearing and grading; the project area is estimated at 11.5 acres (FHWA, WSDOT, and Snohomish County 2016, p. 15) to 12.2 acres (Snohomish County Public Works 2015, p. 9); the clearing limits along the new roadway alignment will be logged; many of the trees will be retained and stockpiled on-site for use in large wood installations; between 8.3 acres (FHWA, WSDOT, and Snohomish County 2016, p. 15) and 8.9 acres (Snohomish County Public Works 2015, p.10) will be restored at project completion with native plantings.

- *Rock Cuts (Removal of Large Rock Obstructions)* **–** between Stations 24+60 and 28+00, and between Stations 30+00 and 32+00, construction of the new roadway section will require removing large rock obstructions from at least 550 linear ft of the alignment (Snohomish County Public Works 2015, p. 9; Snohomish County Public Works 2016, pp. 1-4); conventional earth moving equipment (e.g., excavators, dozers) will be used in combination with hydraulic hammers (or hoe rams), and rock drilling and blasting to remove these known obstructions and possibly other large rock obstructions as they are encountered and construction progresses along the new alignment; the WSDOT and County expect that most of these obstructions will be encountered near the mid-point of the new alignment, including between Stations 25+00 and 28+00 (FHWA, WSDOT, and Snohomish County 2016, p. 13); a typical day removing large rock obstructions will include two or more hours of pre-drilling, followed by one or two controlled blasts, and two or more hours of additional work using hydraulic hammers and excavators (Snohomish County Public Works 2016, p. 1).

- *Building of the Road Prism* and *Slope Stabilization* – construction of the new alignment will require a series of moderate to deep cuts (up to 13 ft) and fills (up to 22 ft); constructed reinforced soil slopes, rock fill slopes, retaining walls (e.g., structural earth walls), and culvert outlet protection will prevent slope instability along the new alignment; gravel and crushed surface base course will be placed and graded when constructing the new roadway prism; approximately 2,400 linear ft of the new alignment will require permanent slope stabilization measures (Snohomish County Public Works 2015, p. 10).

- *Rock Toe Scour Protection* – from Station 34+50 to 45+50 and from Station 48+00 to 54+00 (a total distance of approximately 1,700 linear ft or 0.32 mile), buried rock revetments will be constructed at the toe of the slope and periphery of the CMZ; approximately 10,000 cubic yards of large rock will be placed and buried to protect against future lateral migration of the active channel; large wood will be installed along the face of the buried rock revetments; most of this rock toe scour protection will be constructed along decommissioned roadway sections and abandoned portions of the old alignment (Snohomish County Public Works 2015, p. 10); in-water work along approximately 350 linear ft of the buried rock revetment may require work area isolation with the placement of a temporary cofferdam or bypass (approximately 7,000 ft^2; 350 ft x 20 ft); the WSDOT and County will implement standard WSDOT Fish Exclusion Protocols and Standards (Snohomish County Public Works 2015, p. 12); permanent stabilization of these areas will include topsoil, mulch, and native plantings.

- *Site Drainage* and *Culvert Installations* – non-fish bearing streams located on moderate to steep slopes may be temporarily spanned or bypassed; all temporary and final installations will have outlet protection to prevent downslope erosion and headcutting; final installations will be sized to accommodate and convey the 100-year (design-year) storm event and associated debris.

- *Bridge Construction* – a new 180-foot bridge with drilled-shaft foundations will be constructed at the stream crossing near Station 54+00; construction will require little or no in-water work (Snohomish County Public Works 2015, p. 12), but will result in temporary impacts to floodplain wetlands; construction may require a temporary bridge span placed on earth, rock, or ecology block foundations and fills.

- *Decommissioning, Demolition, and Removal of the Old Alignment and Roadway Sections* – approximately 1,800 linear ft and 46,000 ft^2 of damaged roadway (65 to 180 cubic yards of asphalt and compacted base course) will be removed from portions of the old alignment that are located above the ordinary high water mark (OHWM) (Snohomish County Public Works 2015, p. 12; FHWA, WSDOT, and Snohomish County 2016, p. 57); in addition, approximately 8,000 ft^2 of asphalt and roadway debris will be removed from approximately a half-dozen locations below the OHWM; equipment will gain access to complete the work from remaining portions of the old road prism, and with the possible temporary placement of timber cribbing and crane mats (Snohomish County Public Works 2015, pp. 11, 34); equipment may also traverse and work from exposed channel bars; approximately 5,000 ft^2 below the OHWM will be enhanced with large wood installations; once the decommissioned roadway sections are removed, soil decompaction and placement of organic materials, including salvaged topsoil and forest duff, will prepare the site for native plantings; approximately 1,750 native shrubs and trees meeting USFS requirements and specifications will be planted to restore 1 acre of riparian buffer throughout the abandoned alignment (Snohomish County Public Works 2015, pp. 12, 13); habitat structures, including standing snags, brush piles, fallen trees, and stumps, will be placed throughout the restored riparian buffer.

Conservation Measures

The proposed action will result in the relocation of an approximately one half-mile (0.5 mile) section of Index-Galena Road away from the left-bank side channel to the mainstem North Fork Skykomish River, away from the CMZ, and above the 100-year floodplain. The action will reduce a significant, long-standing constraint on the CMZ, and restore channel-forming processes and floodplain and riparian processes that contribute to the creation and maintenance of complex instream habitat. The proposed action incorporates best management practices (BMPs) and permanent design elements (e.g., use of low-volume roadway design standards; use of constructed reinforced soil slopes and retaining walls; application of USFS specifications for riparian buffer enhancement and restoration) that will avoid and reduce impacts to sensitive resources, including wetlands, floodplain, and forest.

The FHWA, WSDOT, and County have also proposed conservation measures to avoid and reduce impacts during construction (Snohomish County Public Works 2015, pp. 10, 13, 14; FHWA, WSDOT, and Snohomish County 2016, pp. 49, 50, 54, 55, 59, 60, 67-69). The conservation measures are incorporated here by reference; what follows is only our summary of some of the most important measures:

- Between April 1 and September 23, all work will start 2 hours after sunrise and stop 2 hours before sunset.

- The FHWA, WSDOT, and County will implement an engineer-approved Spill Prevention, Control, and Countermeasures (SPCC) plan. A current copy of the SPCC plan will be maintained onsite for the duration of the project and no work or staging in advance of work will commence prior to implementing the plan. The approved SPCC plan will provide site- and project-specific details identifying potential sources of pollutants; exposure pathways; spill response protocols; protocols for routine inspection, fueling, and maintenance of equipment; preventative and protective equipment and materials; and, emergency notification and reporting protocols.

- The FHWA, WSDOT, and County will use suitable, engineer-approved locations for on-site staging of equipment and materials during construction.

- The clearing limits will be identified in the field with high-visibility construction fencing.

- No more than 5 acres of soil disturbance will be permitted at one time.

- The FHWA, WSDOT, and County will implement USFS procedures and requirements for the control of noxious weeds and invasive nonnative species.

- All work below the OHWM will comply with the Hydraulic Project Approval issued for the project by the Washington State Department of Fish and Wildlife (WDFW).

- All work below the OHWM will be completed during the approved in-water work window (August 1 to August 31).

- Any equipment entering the water will use vegetable oil or another biodegradable hydraulic fluid substitute.

- Where practicable and necessary to avoid and reduce impacts to fish, work areas will be isolated with the placement of a temporary cofferdam or bypass.

- The FHWA, WSDOT, and County will implement standard WSDOT Fish Exclusion Protocols and Standards.

- Any pumps used to temporarily bypass water or to dewater residual pools will be screened at the intake. Fish screens or guards will comply with Washington State law (RCW 77.57.010 and 77.57.070), with guidelines prescribed by the National Marine Fisheries Service (NMFS), and any more stringent requirements contained in permits issued for the project by the WDFW. Pumps will not be operated without a screened intake unless there is no risk of entraining fish, and there are adequate plans in place to address contingencies (including a routine schedule for inspection).

- Work will not inhibit fish passage during or after construction.

- The FHWA, WSDOT, and County will use coniferous species with a minimum stem/bole diameter of 18 inches when installing large wood along the face of the buried rock revetments.

- The FHWA, WSDOT, and County will monitor turbidity resulting from construction activities in accordance with the Clean Water Act section 401 Water Quality Certification issued for the project by the Washington State Department of Ecology. The project will monitor for exceedances of the State of Washington aquatic life turbidity criteria, five nephelometric turbidity units (NTUs) over background when less than 50 NTU (10 percent increase over background when more than 50 NTU). Trained staff will collect background (upstream) and downstream measures of turbidity during the course of in-water work and shall have the authority to take all measures necessary, including temporary cessation of work, to ensure compliance with criteria at the downstream extent of the allowed mixing zone.

- The FHWA, WSDOT, and County will monitor replanted areas for 10 years to ensure mitigation success.

- Bridge piers and abutments will be constructed landward of the OHWM to minimize wetland and stream impacts.

- The FHWA, WSDOT, and County will use flow dispersion and infiltration as the preferred means to control and treat stormwater runoff, and will avoid concentrating stormwater runoff to the maximum extent practicable. Consistent with the requirements of the WSDOT Highway Runoff Manual, additional flow control and/or treatment BMPs will be implemented where warranted and practicable.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluate the farthest reaching physical, chemical, and biotic effects of the action on the environment.

The terrestrial boundaries of the action area were defined based on the extent of temporary sound and visual disturbance that will result during construction. The Service conducted an independent analysis of in-air sound generation and attenuation using conservative assumptions. The following assumptions are likely to overstate, rather than understate, the potential physical extent (i.e., distance) to which temporary increased sound levels may exceed ambient, background sound levels:

- An ambient sound level of approximately 52 dBA (USFS 1996);

- A traffic sound level of approximately 57 dBA, corresponding to a traffic volume of approximately 125 vehicles per hour at 35 mph (WSDOT 2015, p. 7.11);

- A construction sound level of approximately 93 dBA, assuming simultaneous operation of three pieces of conventional heavy equipment (e.g., pavement scarifier at 90 dBA; heavy dump truck at 90 dBA) and applying accepted rules for decibel addition (U.S. Department of Transportation 1995; WSDOT 2015, pp. 7.15, 7.16);

- A construction sound level of approximately 126 dBA, representing the average L_{max} measured at 50 ft for rock slope production blasting (WSDOT 2015, p. 7.12); and,

- Sound generation and attenuation was modeled as a point source transmitted across a “soft,” forested landscape.

Model outputs suggest that traffic sound levels attenuate to ambient sound levels at a distance of approximately 110 ft. Model outputs indicate that sound levels associated with typical construction activities using conventional heavy equipment will attenuate to ambient sound levels at a distance of approximately 2,000 ft.

Temporary increases in sound associated with blasting operations will have the farthest reaching effects in the terrestrial environment. Model outputs indicate that sound levels resulting from blasting operations will attenuate to ambient sound levels at a distance of more than 4 miles, will attenuate to 70 dBA (A-weighted decibels referenced to 20 micropascals) at a distance of approximately 1.5 miles, and to 92 dBA at a distance of approximately 0.2 mile.

Topography and a variety of other environmental conditions influence in-air sound attenuation. The action area is characterized by steep canyon walls, which extend from the valley bottoms (at approximately 850 ft above sea level) to surrounding high ridges and peaks (up to 5,200 ft above sea level). Unfortunately, there is no simple and accurate means to predict or discern how the action area's complicated topographical setting will influence three-dimensional in-air sound attenuation.

Taking all these factors into consideration, the Service concludes that a 4-mile radius action area very likely exceeds and exaggerates the actual physical extent of temporary increased sound levels associated with construction. Instead, Figure 9 (below) identifies the proposed new alignment (green line feature), a 1.5-mile buffer, and 0.25-mile buffer from proposed construction activities.

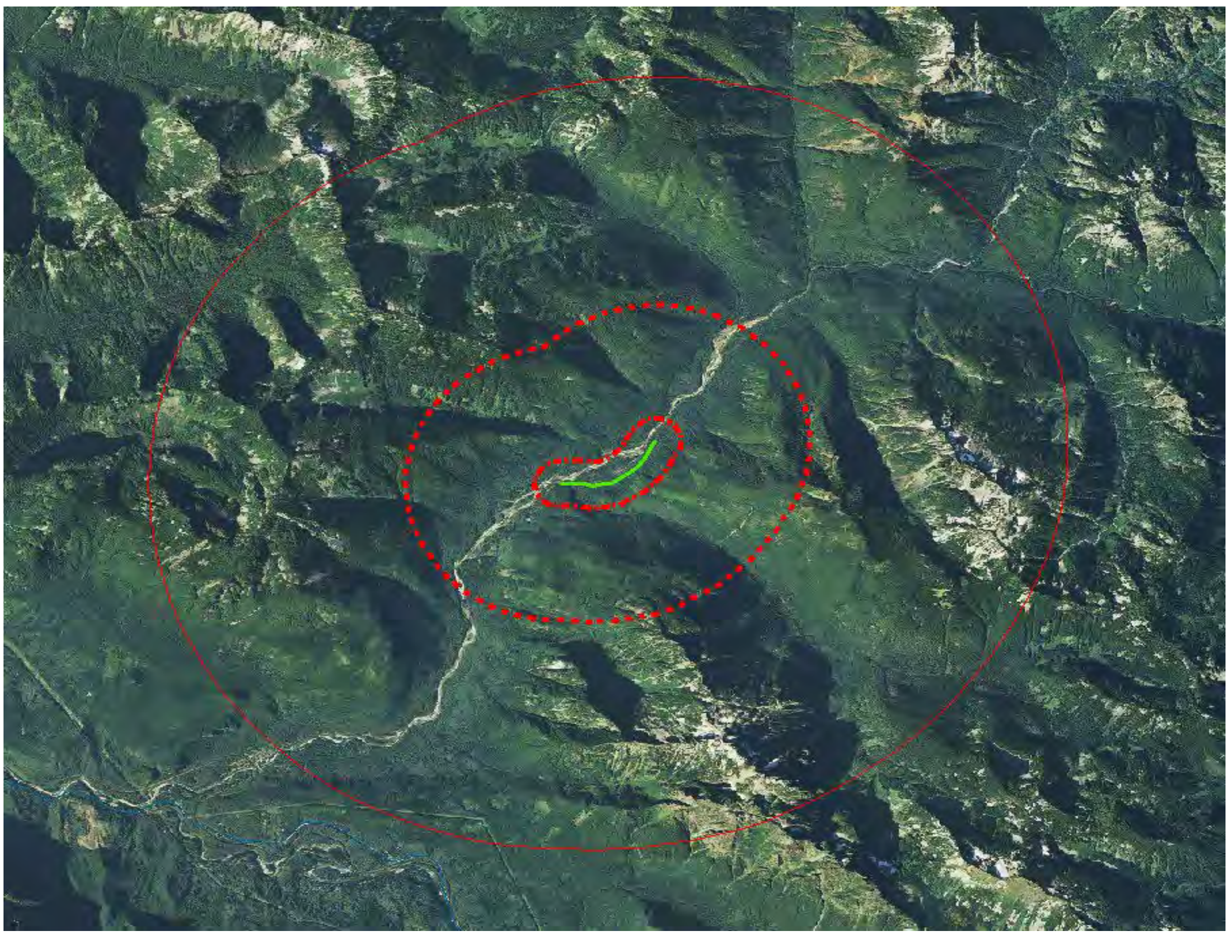

Figure 9. Aerial photo depicting the proposed roadway alignment, 0.25- and 1.5- mile buffers, and 4-mile action area.

The aquatic boundaries of the action area were defined with consideration for the following:

- Where, and how far, are suspended sediments expected to extend upstream and downstream of work activities during construction?

- Where, and how far, are bedload movements, large wood transport and accumulation, and channel formation processes likely to be influenced (directly or indirectly) by construction of the project?

We expect that turbidity and sedimentation resulting from in-water work will have the farthest reaching effects in the aquatic environment during the period of construction. However, with a footprint that includes approximately 12 acres of clearing and grading on steep side slopes (i.e., moderately steep to very steep side slopes), we also acknowledge that some work completed in the uplands may become a source of turbidity and sedimentation further downslope. Based upon the nature of the proposed work, the size, volume, and morphology of the North Fork Skykomish River within the action area, and the conditions likely to prevail during construction, we expect that turbidity and sedimentation resulting from construction activities will travel as far as 300 ft downstream before concentrations are diminished by dilution and deposition such that they become difficult to distinguish from background/ambient concentrations.

We also expect, that by relocating an approximately one half-mile (0.5 mile) section of Index-Galena Road away from the CMZ and 100-year floodplain, and by reducing a significant, long-standing constraint on the CMZ at this location, the proposed action will have measurable effects on a localized scale (though likely beneficial effects) to bedload movement, large wood transport and accumulation, and channel formation processes. The Service expects that the proposed action will have measurable direct and indirect effects to approximately 1 linear mile of the North Fork Skykomish River, including its left-bank side channel, the CMZ, and associated portions of the 100-year floodplain.

ANALYTICAL FRAMEWORK FOR THE JEOPARDY AND ADVERSE MODIFICATION DETERMINATIONS

Jeopardy Determination

The following analysis relies on the following four components: 1) the *Status of the Species*, which evaluates the rangewide condition of the listed species addressed, the factors responsible for that condition, and the species' survival and recovery needs; 2) the *Environmental Baseline*, which evaluates the condition of the species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; 3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed federal action and the effects of any interrelated or interdependent activities on the species; and 4) *Cumulative Effects*, which evaluates the effects of future, non-federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed federal action in the context of the species' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of listed species in the wild.

The jeopardy analysis in this Opinion emphasizes the rangewide survival and recovery needs of the listed species and the role of the action area in providing for those needs. It is within this context that we evaluate the significance of the proposed federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), "physical or biological features" (PBFs), or "essential features" to characterize the key components of critical habitat that provide for the conservation of the listed species. The new critical habitat regulations (81 FR 7214) discontinue use of the terms PCEs or essential features, and rely exclusively on use of the term PBFs for the purpose contained in the statute. The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. For these reasons, in this Opinion, references to PCEs should be viewed as synonymous with PBFs. Either set of terms characterizes the key components of critical habitat that provide for the conservation of the listed species.

Our analysis of effects to critical habitat relies on the following four components: 1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the bull trout in terms of PCEs or PBFs, the factors responsible for that condition, and the intended recovery function of the critical habitat overall; 2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; 3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed federal action and the effects of any interrelated or interdependent activities on the PCEs or PBFs and how that will influence the recovery role of affected critical habitat units; and 4) *Cumulative Effects*, which evaluates the effects of future, non-federal activities in the action area on the PCEs or PBFs and how that will influence the recovery role of affected critical habitat units.

For purposes of making the destruction or adverse modification finding, the effects of the proposed federal action, together with any cumulative effects, are evaluated to determine if the critical habitat rangewide will remain functional (or retain the current ability for the PBFs to be functionally re-established in areas of currently unsuitable but capable habitat) to serve its intended conservation/recovery role for the species.

STATUS OF THE SPECIES: Bull Trout

For a detailed account of bull trout biology, life history, threats, demography, and conservation needs, refer to Appendix A: Status of the Species – Bull Trout.

STATUS OF CRITICAL HABITAT: Bull Trout

For a detailed account of the status of designated bull trout critical habitat, refer to Appendix B: Status of Designated Critical Habitat – Bull Trout.

STATUS OF THE SPECIES: Marbled Murrelet

For a detailed account of marbled murrelet biology, life history, threats, demography, and conservation needs, refer to Appendix C: Status of the Species – Marbled Murrelet.

ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed federal projects in the action area that have undergone section 7 consultation, and the impacts of state and private actions which are contemporaneous with the consultation in progress.

The proposed project and action area are located in the North Cascades physiographic region, which extends from British Columbia south to Snoqualmie Pass. The region is characterized by steep topography, numerous peaks and glaciers, and glacially-carved valleys (Snohomish County Public Works 2015b, p. 18).

The action area extends along approximately 1 linear mile of the North Fork Skykomish River, its CMZ, and 100-year floodplain. The proposed project is located at river mile (RM) 7.0, approximately 7 miles upstream from where the North and South Fork Skykomish Rivers converge west of the Town of Index.

The North Fork Skykomish River drains an estimated 93,960 ac, most of which is located in the MBSNF. The upper 10 miles (RM 20 to 30) flows in a relatively confined, incised channel heavily armored with boulders and cobbles (Snohomish County Public Works 2015b, p. 18). Between RM 18.5 and 15, the North Fork broadens somewhat, but still with steep valley wall side slopes. From RM 15 to 10 the valley narrows again with very steep side slopes (USFS 1997 *in* Snohomish County Public Works 2015b). The valley broadens in the last few miles as it approaches the Town of Index.

The North Fork Skykomish River has a relatively narrow floodplain and there are many tributary streams. Some of these are considered debris torrent streams, while others run in larger debris flow ravines (Snohomish County Public Works 2015b, pp. 18-20). The basin is subject to recurrent rain-on-snow and other high flow events that promote channel meandering and migration. Under expected future climate change scenarios, an increase in rain-on-snow events and an increased frequency of high flow events are anticipated (USFS 1997 *in* Snohomish County Public Works 2015b).

Within the action area, the surrounding forested landscape includes both deciduous dominated and mixed coniferous-deciduous dominated riparian forest. The entire project area is within the USFS designated North Fork Skykomish River riparian reserve and lies parallel and adjacent to the boundary of the Wild Sky Wilderness (Snohomish County Public Works 2015b, pp. 18, 20).

The valley bottom deciduous dominated forest includes black cottonwood (*Populus balsamifera* var. *trichocarpa*), red alder (*Alnus rubra*), big-leaf maple (*Acer macrophyllum*), and western red cedar (*Thuja plicata*), with an understory composed of salmonberry (*Rubus spectabilis*), thimbleberry (*Rubus parviflorus*), red elderberry (*Sambucus racemosa*), and sword fern (*Polystichum munitum*)(Snohomish County Public Works 2015b, p. 20). Wetlands and stream courses include vine maple (*Acer circinatum*), red-osier dogwood (*Cornus sericea*), devil's club (*Oplopanax horridus*), willows (*Salix* sp.), and an overstory that often includes western hemlock (*Tsuga heterophylla*).

Higher on the valley walls, the mixed coniferous-deciduous dominated forest represents a western hemlock-sword fern-foamflower (*Tiarella trifoliata*) plant association (Henderson 1992 *in* Snohomish County Public Works 2015b, p. 22). Within the project area and limits of construction these forested habitats consist mostly of second growth mixed conifer-deciduous dominated stands located on rugged, steep, northwest-facing slopes. Dominant species include western hemlock and Douglas-fir (*Pseudotsuga menziesii*), with fewer big-leaf maples and western red cedars. The closest USFS designated LSRs are located approximately one-half (0.5) mile to the southeast where mature forest can be found at higher elevations (Snohomish County Public Works 2015b, p. 22).

ENVIRONMENTAL BASELINE: Bull Trout and Designated Bull Trout Critical Habitat

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed federal projects in the action area that have undergone section 7 consultation, and the impacts of state and private actions which are contemporaneous with the consultation in progress.

The aquatic boundaries of the action area extend along approximately 1 linear mile of the North Fork Skykomish River, its CMZ, and 100-year floodplain (approximate RM 7.0). All or nearly all of these habitats are designated as critical habitat for the bull trout. The North Fork Skykomish River is part of the larger Snohomish-Skykomish River bull trout core area.

Appendix D describes the status, number and distribution of local populations, adult abundance, productivity, connectivity, recent trends, and threats for bull trout from the Snohomish-Skykomish River bull trout core area. The following is only a summary of important and relevant highlights from the core area summary (Appendix D):

- Fluvial, resident, and anadromous life history forms occur in the Snohomish-Skykomish core area. Large portions of the migratory populations are anadromous.

- The topography of the basin limits the amount of spawning and early rearing habitat. Rearing occurs throughout most of the accessible reaches of the basin.

- Among the four documented local populations, three are located in the North Fork Skykomish River or its tributaries: 1) the North Fork Skykomish River (including Goblin and West Cady Creeks), 2) Troublesome Creek (resident form only), and 3) Salmon Creek. Bull trout are not known to occur above Deer Falls on the North Fork Skykomish River. [Note: Troublesome Creek and Salmon Creek enter the North Fork Skykomish River less than 4 miles and less than 2 miles upstream of the action area, respectively.]

- Abundance indices in the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have substantially declined since 2008 (WDFW 2015). The Troublesome Creek local population is mainly a resident population, located upstream of a natural migration barrier, and adult abundance is unknown. The Salmon Creek local population may have fewer than 100 adults. Two local populations (South Fork Skokomish River and Salmon Creek) are at risk from inbreeding depression because they are believed to contain fewer than 100 spawning adults per year. Risk from inbreeding depression for the Troublesome Creek local population is unknown.

- Long-term redd counts for the North Fork Skykomish River local population increased from the time of listing (1998), peaked between 2001 and 2006, and have generally been in decline since. The five-year running average from 2012 to 2014 varied between 83 and 118 redds, which is roughly equivalent to pre-listing levels (75 to 118 redds) despite peaking at 348 to 366 redds between 2004 and 2006.

- Productivity of the Troublesome Creek and Salmon Creek local populations is unknown but presumed to be stable; the available spawning and early rearing habitats, including those within the Henry M. Jackson Wilderness, are in good to excellent condition.

- Good connectivity between three of the four local populations reduces the risk of extirpation from habitat isolation or fragmentation.

- Threats in the upper watershed, where spawning and early rearing occur, include habitat degradation resulting from timber harvest, logging roads, and timber land fertilization.

Current Condition of the Species in the Action Area

The action area includes designated bull trout critical habitat. The action area includes suitable rearing habitat and suitable foraging, migrating, and overwintering (FMO) habitat for bull trout. The action area does not include suitable bull trout spawning habitat. "The known [bull trout] spawning and early rearing habitats of the Skykomish River basin are all found at an elevation of … 1,000 to 1,500 ft … The major areas of production include the North Fork Skykomish River between Bear Creek Falls and Deer Falls, Goblin Creek, Troublesome Creek, and Salmon Creek … [These areas support] as many as 500 migratory adults based on redd counts … Spawning and early rearing habitats are generally in good condition" (USFWS 2004, p. 101). All of these named, major areas of bull trout production, spawning, and early rearing are located between 2 and 10 miles upstream of the action area (Figure 10). The Services assumes that adult, subadult, and juvenile bull trout are likely to be present in the action area at all times of year.

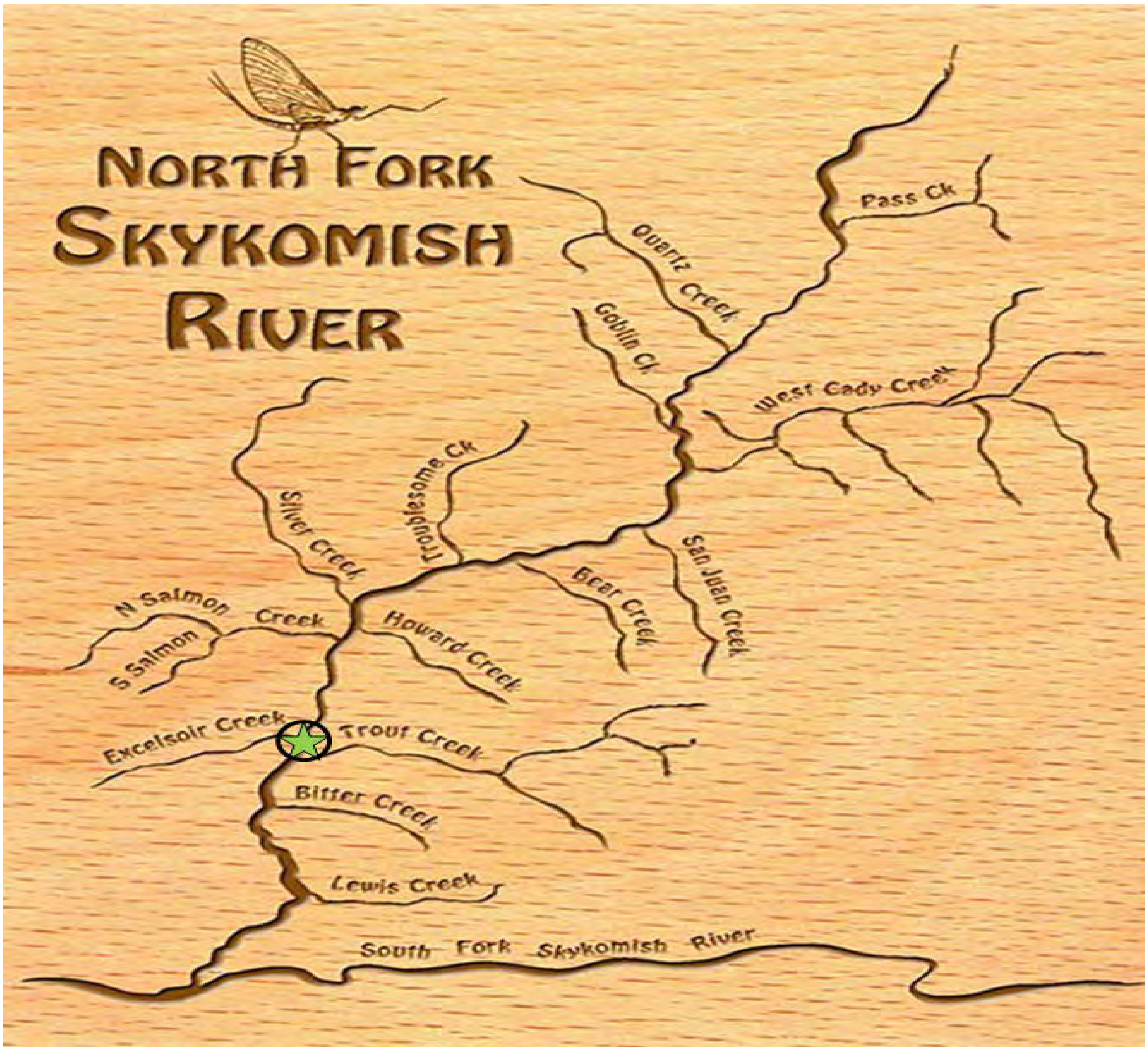

Figure 10. Proximity to spawning and early rearing habitats
(Stonefly Studio 2016)

Table 2 summarizes our assessment of aquatic habitat function in the action area and North Fork Skykomish River sub-basin using the Matrix of Diagnostics/Pathways and Indicators (USFWS 1998). The matrix is a tool for describing whether habitat is "functioning adequately," "functioning at risk," or "functioning at unacceptable levels of risk" at the scales of the action area and watershed. Within the action area, we conclude that two indicators currently function at unacceptable levels of risk (Floodplain Connectivity and Road Density/Location).

Table 2. Baseline aquatic habitat conditions and function

Pathway	Indicator	Action Area	Watershed
Water Quality	Temperature	Functioning Adequately	At Risk
	Sediment	Functioning Adequately	At Risk
	Chemical Contamination & Nutrients	Functioning Adequately	At Risk
Habitat Access	Physical Barriers	At Risk	At Risk
Habitat Elements	Substrate	Functioning Adequately	At Risk
	Large Woody Debris	Functioning Adequately	At Risk
	Pool Frequency/Quality	Functioning Adequately	At Risk
	Large Pools	Functioning Adequately	At Risk
	Off-Channel Habitat	At Risk	At Risk
	Refugia	At Risk	At Risk
Channel Conditions & Dynamics	Width/Depth Ratio	At Risk	At Risk
	Streambank Condition	At Risk	At Risk
	Floodplain Connectivity	Unacceptable Risk	At Risk
Flow/ Hydrology	Peak/Base Flows	At Risk	At Risk
	Drainage Network	At Risk	At Risk
Watershed Conditions	Road Density/Location	Unacceptable Risk	Unacceptable Risk
	Disturbance History	At Risk	At Risk
	Riparian Reserve	At Risk	At Risk

Factors Responsible for the Condition of the Species

Appendix D describes recent trends and threats for bull trout from the Snohomish-Skykomish River bull trout core area. The following is only a summary of important and relevant highlights from the core area summary (Appendix D):

- Since the bull trout listing, federal actions occurring in the Snohomish-Skykomish core area have had short- and long-term effects to bull trout and bull trout habitat. These actions have included statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvements; federally funded transportation projects involving repair and protection of roads and bridges; and, section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Snohomish-Skykomish core area.

- The number of non-federal actions occurring in the Snohomish-Skykomish core area since the bull trout listing is unknown. However, activities conducted on a regular basis, including emergency flood control and infrastructure maintenance, affect riparian and instream habitat, and probably negatively affect bull trout.

- Climate change is expected to negatively affect the Snohomish-Skykomish core area (USFWS 2008, p. 14). Climate change is expected to result in higher water temperatures, lower spawning flows, and increased magnitude of winter peak flows (Battin et al. 2007 *in* USFWS 2008, p. 14). Higher peak flows may increase scour and mortality of eggs, incubating embryos, and pre-emergent juveniles. Bull trout spawning and [early] rearing areas are particularly vulnerable … due to their narrow distribution … within this system (USFWS 2008, p. 14).

Current Condition of Critical Habitat in the Action Area

On October 18, 2010, the Service issued a final revised critical habitat designation for the bull trout (70 FR 63898). The designation includes 32 critical habitat units located throughout the coterminous range of the bull trout in Washington, Oregon, Idaho, Montana, and Nevada (Appendix B). Critical habitat units generally encompass one or more core areas, and include FMO habitat outside of core areas, that are important to the survival and recovery of bull trout.

Within the designated critical habitat units, nine PCEs have been described. The PCEs are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, and sheltering. For a detailed account of the status of designated bull trout critical habitat, refer to Appendix B: Status of Designated Critical Habitat – Bull Trout, and the final rule designating critical habitat (70 FR 63898).

The action area includes approximately 1 linear mile of the North Fork Skykomish River, its CMZ, and 100-year floodplain. The baseline conditions for each PCE are described below:

1) *Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia*.

Within the action area, springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) all contribute to water quality and quantity, and provide thermal refugia. Hydrological and temperature regimes are mostly undisturbed and functioning adequately.

Within the action area, the current function of this PCE is not impaired.

2) *Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers*.

There are no man-made barriers to migration within the action area. However, within the action area, an approximately one half-mile (0.5 mile) section of Index-Galena Road acts as a significant, long-standing constraint on the CMZ, and retards channel-forming processes and floodplain and riparian processes that contribute to the creation and maintenance of complex instream habitat.

Within the action area, the current function of this PCE is moderately impaired.

3) *An abundant food base, including terrestrial organisms of riparian origin and aquatic macroinvertebrates*.

This reach of the North Fork Skykomish River provides an abundant food base for adult, subadult, and rearing bull trout. The North Fork Skykomish River supports populations of Chinook (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), resident rainbow trout (*O. mykiss*), and other native fishes. Side- and off-channel habitats are somewhat limited, but presumably prey of terrestrial origins remain abundant.

Within the action area, the current function of this PCE is only mildly impaired.

4) *omplex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure*.

Within the action area, an approximately one half-mile (0.5 mile) section of Index-Galena Road acts as a significant, long-standing constraint on the CMZ, and retards channel-forming processes and floodplain and riparian processes that contribute to the creation and maintenance of complex instream habitat. Side- and off-channel habitats are somewhat limited, but other forms of instream habitat complexity (e.g., large wood, pools, undercut banks, unembedded substrates) are mostly undisturbed and functioning adequately.

Within the action area, the current function of this PCE is moderately impaired.

5) *Water temperatures ranging from 2 °C to 15 °C (36 °F to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence*.

Within the action area, springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) all contribute to water quality and quantity, and provide thermal refugia. Hydrological and temperature regimes are mostly undisturbed and functioning adequately.

Within the action area, the current function of this PCE is not impaired.

6) *In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system*.

The action area does not provide suitable bull trout spawning habitat, but does provide suitable rearing habitats. Side- and off-channel habitats are somewhat limited, but other forms of instream habitat complexity (including unembedded substrates) are functioning adequately.

Within the action area, the current function of this PCE is only mildly impaired.

7) *A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph*.

Within the action area, hydrological regimes are mostly undisturbed, depart minimally from natural conditions, and are functioning adequately.

Within the action area, the current function of this PCE is not impaired.

8) *Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited*.

Within the action area, springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) all contribute to water quality and quantity, and provide thermal refugia. Hydrological and temperature regimes are mostly undisturbed and functioning adequately.

Within the action area, the current function of this PCE is not impaired.

9) *Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.*

Introduced, nonnative species are identified as a known threat to bull trout in the Goblin Creek sub-basin of the North Fork Skykomish River (USFWS 2004, p. 185). Otherwise, there is little information to suggest that nonnative predatory, interbreeding, or competing species are a significant problem in the action area.

Within the action area, the current function of this PCE is only mildly impaired.

Conservation Role of the Action Area

The action area provides high-functioning rearing and FMO habitats for bull trout. The action area provides habitat that is critically important to all migratory (fluvial and anadromous) bull trout from two of the Snohomish-Skykomish River core area's four local populations (North Fork Skykomish River, including Goblin and West Cady Creeks; Salmon Creek). The North Fork Skykomish River local population is the largest, most abundant, and most productive population in the entire Snohomish-Skykomish River core area. The action area serves as an essential migratory corridor providing connectivity between three of the Snohomish-Skykomish River core area's four local populations; the Troublesome Creek local population includes a resident life history form only.

On September 28, 2015, the Service announced the availability of a Recovery Plan for the Coterminous U.S. Population of Bull Trout (USFWS 2015a). The Recovery Plan updates the recovery criteria proposed in the 2002 and 2004 draft recovery plans, to focus on effective management of threats, and de-emphasize the achievement of targeted population numbers (i.e., numbers of adult bull trout in specific areas) (USFWS 2015b).

In developing the Recovery Plan, the Service recognized that bull trout continue to be found in suitable habitats and generally remain geographically widespread across 110 core areas in five states. The Recovery Plan identifies conservation needs for bull trout in each of the 110 core areas. However, the Service acknowledges, that despite the best conservation efforts, it is likely that bull trout will become locally extirpated from some core areas within the foreseeable future. Factors responsible for declining populations and/or local extirpations include impacts of stochastic events on existing small populations, climate change, and isolation (35 of 110 extant core areas comprise a single local population). Moreover, the availability of survey data for accurate population estimates is problematic, and in certain core areas the geographic limitations on available habitat may inherently constrain the ability of bull trout populations to achieve the earlier demographic targets (USFWS 2015c).

The strategy set forth in the Recovery Plan has five key elements (USFWS 2015c):

- Conserve bull trout so that they are geographically widespread across representative habitats and demographically stable in six recovery units;

- Effectively manage and ameliorate the primary threats in each of six recovery units at the core area scale so that bull trout are not likely to become endangered in the foreseeable future;

- Build upon the numerous and ongoing conservation actions implemented on behalf of bull trout, and improve our understanding of how various threat factors potentially affect the species;

- Use that information to work with partners to design, fund, prioritize, and implement effective conservation actions in those areas that offer the greatest long-term benefit to sustain bull trout, and where recovery can be achieved; and

- Apply adaptive management principles to implementing the bull trout recovery program to account for new information.

The Recovery Plan includes individual Recovery Unit Implementation Plans (RUIPs) for each recovery unit. The RUIPs were developed through collaboration with federal, Tribal, State, private, and other partners (USFWS 2015b).

The Service does not expect, plan, or intend to fully recover all bull trout populations in each of the currently occupied core areas identified by the Recovery Plan. We recognize that accomplishing recovery at the scale of the recovery units will require that we improve the status of bull trout local populations, and their habitats, in some core areas relative to the time of listing. However, in other core areas it may only be necessary to maintain bull trout local populations and their habitats, more or less in their current condition, into the foreseeable future.

If the threats described in the Recovery Plan are effectively managed, the Service expects that bull trout populations in each recovery unit will respond accordingly, reflecting the biodiversity principles of resiliency, redundancy, and representativeness. Specifically, achieving the proposed recovery criteria in each recovery unit would result in geographically widespread and demographically stable local bull trout populations, and would protect their essential cold water habitats to allow all diverse life history forms to persist into the foreseeable future (USFWS 2015a, p. viii).

Connectivity between spawning, rearing, and downstream FMO habitats is necessary for the expression of migratory life history patterns. In core areas where multiple local populations exist, interaction among local populations through movement of migratory individuals is critical to maintaining genetic diversity and recolonizing local populations that become extirpated. Thus, when connectivity with FMO habitat is impaired or blocked, bull trout populations tend to become restricted to isolated local populations, which may have low genetic diversity, are vulnerable to extirpation, and cannot be readily recolonized. Barriers to connectivity may consist of natural physical features such as waterfalls; river reaches that create mortality risks or prevent movement of adult fish because of entrainment, excessively warm water, or poor water quality; instream structures such as culverts or weirs; or dams (USFWS 2015a, p. 27).

The Recovery Plan identifies the following recovery actions (USFWS 2015a, pp. 51, 52):

1. Protect, restore, and maintain suitable habitat conditions for bull trout.

2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.

3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.

4. Work with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery actions, and considering the effects of climate change.

The Coastal Recovery Unit is located within western Oregon and Washington. Major drainages include the Olympic Peninsula, Puget Sound, and Lower Columbia River basins, Upper Willamette River, Hood River, Lower Deschutes River, Odell Lake, and the Lower Mainstem Columbia River. In the Coastal Recovery Unit, the Service identified 21 existing bull trout core areas, including the Clackamas River core area where bull trout had been extirpated and were recently reintroduced, and 4 historically occupied core areas that could be reestablished. Core areas within the recovery unit are distributed among three geographic regions: Puget Sound, Olympic Peninsula, and Lower Columbia River. The only core areas in the coterminous states that currently support anadromous local populations of bull trout are located within the Puget Sound and Olympic Peninsula geographic regions (USFWS 2015a, pp. 38, 79).

The RUIP for the Coastal Recovery Unit includes the following specifics regarding bull trout recovery actions for the Snohomish-Skykomish River core area (USFWS 2015d, pp. A-50 through A-52):

- Reduce stream channel degradation and increase channel complexity. Where feasible remove existing and prevent future bank armoring and channel constrictions associated with development and agriculture; restore connectivity to floodplain; and recreate lost off-channel habitat, and opportunities for off-channel habitat formation through time by protecting channel migration areas from encroachment.

- Practice non-intrusive flood control and flood repair activities. Provide technical assistance to Counties, Cities, and private landowners to develop options for fish friendly flood control methods and repair techniques. Ensure that negative effects to bull trout habitat from ongoing flood control activities (e.g., dredging, woody debris removal, channel clearing, hardened bank stabilization, and riparian removal from dikes and levees) are avoided or minimized. Alternatives should emphasize restoration of floodplain connectivity and the elimination or setback of existing armored banks, dikes, and levees to restore habitat forming processes.

- Implement restoration and protection activities in development areas to reduce water temperatures. Conversion of forested lands have removed cover and reduced instream habitat complexity. Implement established restoration strategies/actions to reduce stream temperatures in the Snohomish River Basin.

- Continue ongoing population monitoring efforts within the basin. Maintain current long-term datasets assessing abundance and distribution of bull trout. This will be critical to detect any significant changes in population distribution and abundance.

Climate Change

Future climate change impacts on bull trout will require development of a decision framework to help inform where climate change effects are most likely to impact bull trout. The identification of core areas and watersheds that are most likely to maintain habitats suitable for bull trout over the foreseeable future, and under probable climate change scenarios, will help guide the allocation of bull trout conservation resources to improve the likelihood of recovery (USFWS 2015a, p. 53).

The Recovery Plan summarizes our current knowledge of potential future climate change scenarios, and their significance for bull trout recovery (USFWS 2015a, pp. 17-19, 30, 31). Bull trout are vulnerable to the effects of warming climates and changing precipitation and hydrologic regimes. Climate change in the Pacific Northwest will include rising air temperatures, changes in the timing and volume of streamflow, increases in extreme precipitation events, and other changes that are likely to degrade bull trout habitat and increase competition with non-native warmwater fish (Mote et al. 2014).

Several climate change assessments or studies have been published (Rieman et al. 2007; Porter and Nelitz. 2009; Rieman and Isaak 2010; Isaak et al. 2010, 2011; Wenger et al. 2011; Eby et al. 2014) or are currently underway assessing the possible effects of climate change on bull trout. The results of these efforts will allow us to better understand how climate change may influence bull trout, and help to identify suitable conservation actions to improve the status of bull trout throughout their range. Issues include: the effects of rising air temperatures and lower summer flows on range contractions; changing stream temperatures, influenced by stream characteristics (e.g., amount of groundwater base flow contribution to the stream, stream geomorphology, etc.) affecting suitable bull trout spawning and rearing habitat; threats to redds and juvenile habitat from stream scouring caused by increased winter precipitation extreme events and increased rain in lower elevations; and lower summer flows inhibiting movement between populations, and from spawning and rearing habitat to foraging habitat (USFWS 2015a, p. 18).

A study of changing stream temperatures over a 13-year period in the Boise River basin estimated an 11 to 20 percent loss of suitable cold water bull trout spawning and early juvenile rearing habitats (Isaak et al. 2010). These results suggest that a warming climate is already affecting suitable bull trout instream habitats. This is consistent with the conclusions of Rieman et al. (2007) and Wenger et al. (2011) that bull trout distribution is strongly influenced by climate, and predicted warming effects could result in substantial loss of suitable bull trout habitats over the next several decades. Wenger et al. (2011) also noted that bull trout already seem to inhabit the coldest available streams in some study areas, and in several watersheds bull trout do not have the potential to shift upstream with warming stream temperatures at lower elevations (USFWS 2015a, p. 18).

Sensitivity of stream temperature to changes in air temperature is complex and is influenced by geological and vegetational factors such as topography, groundwater recharge, glaciation history, and riparian vegetation (Isaak et al. 2010; Isaak and Rieman 2013). A new stream temperature data collection, modeling and mapping project, NorWeST, provides a much improved foundation for assessing bull trout cold water habitat (USFS 2014). Stream temperature data have been compiled from dozens of resource agencies at more than 15,000 unique stream sites. These temperature data are being used with spatial statistical stream network models to develop an accurate and consistent set of climate scenarios for all streams (USFWS 2015a, p. 19).

Fine-scale assessments of the current and projected future geographic distribution of cold water streams and suitable bull trout habitat have been recently developed through the NorWeST (Isaak et al. 2015) and Bull Trout Vulnerability Assessment (Dunham 2015) processes. These assessments model probability of presence using the NorWeST stream temperature data and models, and map suitable habitat “patches” using fish presence, local threats, migratory connectivity, and climate sensitivity. The climate sensitivity parameters and data that will be linked to patches include flow variability (e.g., percent high frequency of winter floods), thermal variability (percent very cold), fire history (percent severely burned relative to patch area), and snowpack (snow cover frequency). Other factors include composite indicators of human impacts and non-native presence. Connectivity parameters include data among patches (stream/lake/sea distance to nearest occupied patch), migratory connectivity (distance to lake/sea), local barriers (culverts, diversions), and natural geomorphic features (USFWS 2015a, p. 19).

Climate change is an independent threat to bull trout, but also one that exacerbates many of the other threats. The Service expects the threat to increase in severity over coming decades. Increasing air temperatures and other changes to hydrology, modified by local habitat conditions, will tend to result in increased water temperatures, and reduce the amount of habitat with suitable cold water conditions. Warm dry conditions are also likely to increase the frequency and extent of forest fires, with a potential to increase sedimentation and eliminate riparian shading. Projected lower instream flows and warmer water in FMO habitats will exacerbate the lack of connectivity within and between bull trout core areas. And, we expect that increased water temperatures will alter competitive interactions between bull trout and other fish species that are better adapted to warm conditions. Climatic warming will change seasonality of streamflow, and increased spring runoff from rain-on-snow events will increase scouring of spawning gravels. Glacial retreat and reduction of summer snowpack will reduce cold water flows during summer months. Sea level rise will result in the loss of, and changes to, nearshore and estuarine habitat. Although addressing the root causes of greenhouse gas emissions and climate change is not within our jurisdiction, management planning should account for these increased threats and proactively protect those habitats that we expect will best maintain cold water conditions suitable for bull trout (USFWS 2015a, pp. 30, 31).

ENVIRONMENTAL BASELINE: Marbled Murrelet

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed federal projects in the action area that have undergone section 7 consultation, and the impacts of state and private actions which are contemporaneous with the consultation in progress.

The Service has determined that temporary increased sound levels associated with routine construction activities are likely to exceed ambient, background sound levels to a distance of approximately 2,000 ft. However, sound levels resulting from blasting operations will attenuate to 70 dBA at a distance of approximately 1.5 miles, and to 92 dBA at a distance of approximately 0.2 mile. The terrestrial boundaries of the action area extend to a distance of at least 1.5 miles (Figure 9).

The surrounding forested landscape includes both deciduous dominated and mixed coniferous-deciduous riparian forest. The entire project area is within the USFS designated North Fork Skykomish River riparian reserve. Within the project area and limits of construction these forested habitats consist mostly of second growth mixed conifer-deciduous stands located on rugged, steep, northwest-facing slopes. The closest USFS designated LSRs are located approximately one-half (0.5) mile to the southeast where mature forest can be found at higher elevations (Snohomish County Public Works 2015b, p. 22).

Current Condition of the Species in the Action Area

The Recovery Plan for the Threatened Marbled Murrelet in Washington, Oregon, and California (USFWS 1997, p. 115) identifies six Conservation Zones throughout the listed range of the species. Conservation Zone 1 (Puget Sound) includes all the waters of Puget Sound and most waters of the Strait of Juan de Fuca south of the U.S.-Canadian border. Conservation Zone 2 (Western Washington Coast Range) includes marine waters within 1.2 miles (2 km) off the Pacific Ocean shoreline, with the northern terminus immediately south of the U.S.-Canadian border near Cape Flattery along the midpoint of the Olympic Peninsula, and extending to the southern border of Washington (the Columbia River)(USFWS 1997, p. 126).

The project and action area are located in marbled murrelet Conservation Zone 1 (Puget Sound). Marbled murrelets that potentially nest in the action area are considered part of the Conservation Zone 1 marbled murrelet population. Much of the Puget Trough's mature forest has been replaced by urban and suburban development. The suitable marbled murrelet habitat remaining in Conservation Zone 1 is typically a considerable distance from the marine environment (USFWS 1997).

With the establishment of the Northwest Forest Plan in 1994, the range of the marbled murrelet in Washington for management and conservation purposes was considered to extend 55 miles inland from marine waters (Raphael et al. 2006, p. 101). The entire action area is located within the range of the marbled murrelet.

Appendix C (Status of the Species – Marbled Murrelet) describes distribution of nesting habitat, abundance, reproduction, population status and trends, conservation needs, and threats with a focus on Conservation Zones 1 and 2. The following is only a summary of important and relevant highlights from the Appendix C:

- The primary reasons for listing included extensive loss and fragmentation of the older-age forests that serve as nesting habitat for marbled murrelets, and human-induced mortality in the marine environment from gillnets and oil spills (57 FR 45328 [Oct. 1, 1992]).

- Due mostly to historic timber harvest, only a small percentage (approximately 11 percent) of the habitat-capable lands within the listed range of the marbled murrelet currently contain potential nesting habitat (Raphael et al. 2015b, p. 118)

- Most marbled murrelets appear to nest within 37 miles of the coast, although occupied behaviors have been recorded up to 52 miles inland, and marbled murrelet presence has been detected up to 70 miles inland in Washington (Huff et al. 2006, p. 10).

- The reliance of marbled murrelets on cryptic coloration to avoid detection suggests they utilize a wide spacing of nests in order to prevent predators from forming a search image (Ralph et al. 1995). Individual marbled murrelets may express fidelity to nest sites or nesting areas, although this is has only been confirmed with marked birds in a few cases (Huff et al. 2006, p. 11).

- Population monitoring from 2001 to 2013 indicates strong evidence for a linear decline of marbled murrelet subpopulations in Washington, while trends in Oregon and northern California indicate potentially stable or increasing subpopulations with no conclusive evidence of a positive or negative trend over the monitoring period (Falxa et al. 2015, p. 26).

- Population size and distribution is strongly and positively correlated with the amount and pattern (large contiguous patches) of suitable nesting habitat; marine factors also contribute to observable trends (Raphael et al. 2015a, p. 156). Terrestrial habitat and the marine human footprint (i.e., shipping lanes, boat traffic, shoreline development) appear to be the most important factors that influence the marine distribution and abundance in Zone 1 (Raphael et al. 2015a, p. 163)

- Considering the best available data on abundance, distribution, population trend, and the low reproductive success of the species, the Service concludes that the population in Washington currently has little or no capability to self-regulate, as indicated by the significant, annual decline in abundance in Conservation Zones 1 and 2.

Habitat Suitability in the Action Area

Observations made in the field on January 12, 2016, confirm that the second growth stands located within the project area do not provide suitable marbled murrelet nesting habitat. These stands do exhibit high canopy closure (>70 percent) at some locations. However, a multi-storied canopy providing good vertical and horizontal cover is generally absent. Although few, if any, trees with lateral limbs providing a 4 inch-diameter (minimum) platform (located 33 or more ft off the forest floor) were observed throughout the limits of construction (estimated at 11.5 to 12.2 acres), the field survey was not comprehensive and did not include all trees within 0.25 mile of the project corridor.

There are 14 marbled murrelet survey stations located within 4 miles of the project area. However, no surveys have been conducted during the last 20 years. An undated data set compiled by the MBSNF includes 8 records of observed marbled murrelets within 4 miles of the project area. The closest observations are located more than 1.5 miles from the project area. There are no current data to describe marbled murrelet occupancy in the action area, and no ornithological radar survey data for these portions of the MBSNF.

In the absence of reliable current survey data to describe occupancy, we used available rangewide maps of nesting habitat produced by MaxEnt species distribution modeling (with 2012 aerial imagery) to predict landscape-scale patterns of marbled murrelet habitat suitability and distribution (Raphael et al. 2016). A coarse-scaled spatial analysis of these data and model outputs suggests that the action area, extending to a distance of approximately 1.5 miles, is approximately 6,665 acres in size and contains approximately 934 acres of suitable to highly suitable marbled murrelet nesting habitat. These patches of suitable habitat are fragmented and discontinuous (Figure 11). These suitable habitats are located upslope, across the valley, and higher on the valley walls than the project area. This same analysis suggests that of the approximately 488 acres (total) located within 0.25 mile of the project corridor, only 18 acres represent suitable to highly suitable marbled murrelet nesting habitat (Figure 12).

The nearest designated critical habitat for the marbled murrelet is located to the southeast at a distance of at least 2,000 ft. There is only one polygon within 1.5 miles corresponding to (or representing) designated critical habitat. It appears today that this polygon includes mostly second growth conifers; the stand is not mapped as suitable marbled murrelet nesting habitat.

Based upon information included in the BA and BA amendment, a review of available recent aerial photography, observations made in the field, and the above described coarse-scaled spatial analysis, the Service may reasonably conclude that some portion of the suitable, un-surveyed habitat in the action area (approximately 934 acres) is occupied. It is also reasonable to assume that some portion of the suitable, un-surveyed marbled murrelet nesting habitat located within 0.25 mile of the project corridor (approximately 18 acres) is occupied.

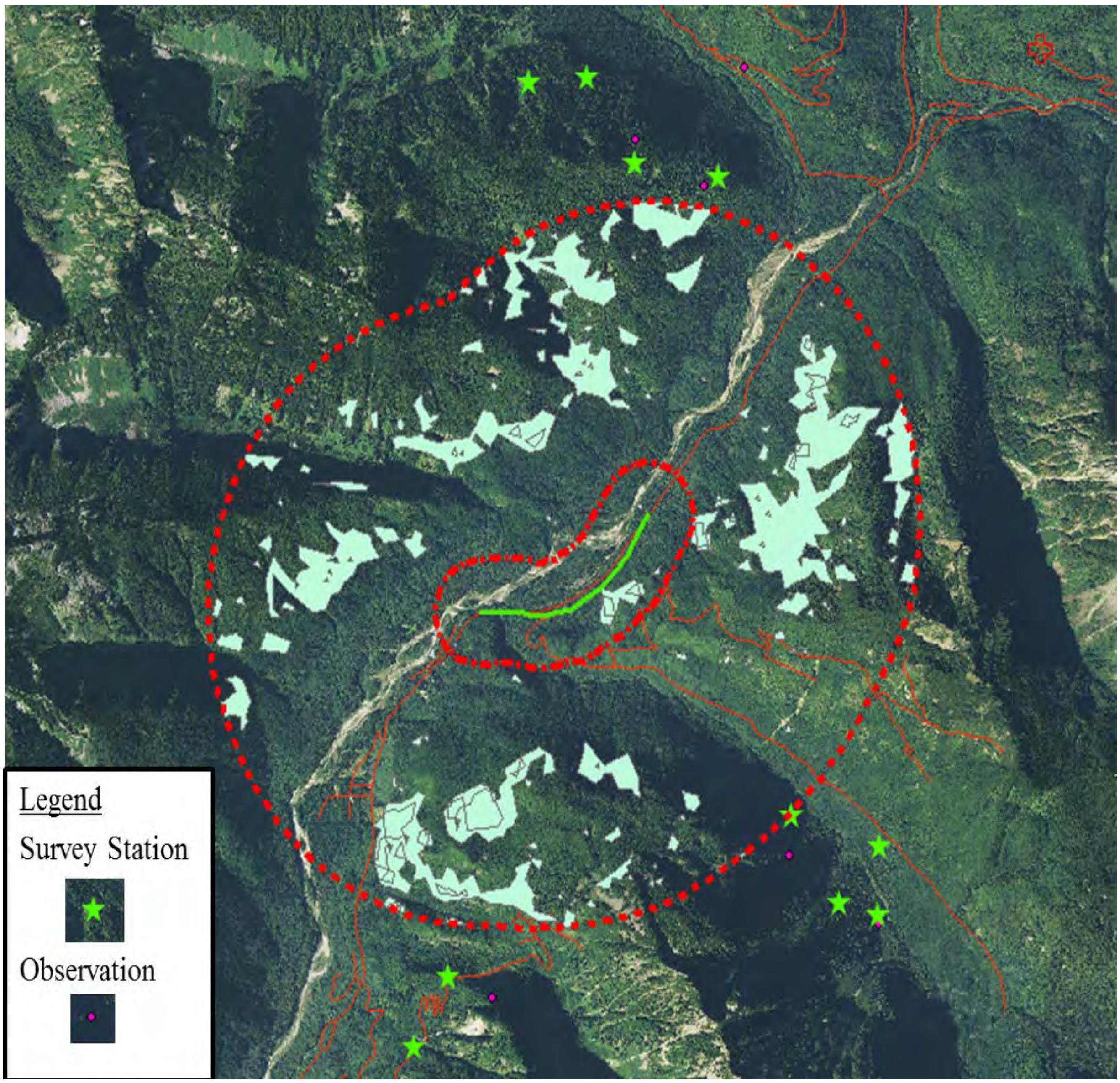

Figure 11. Screenshot depicting marbled murrelet habitat suitability data, survey stations, and historic observations

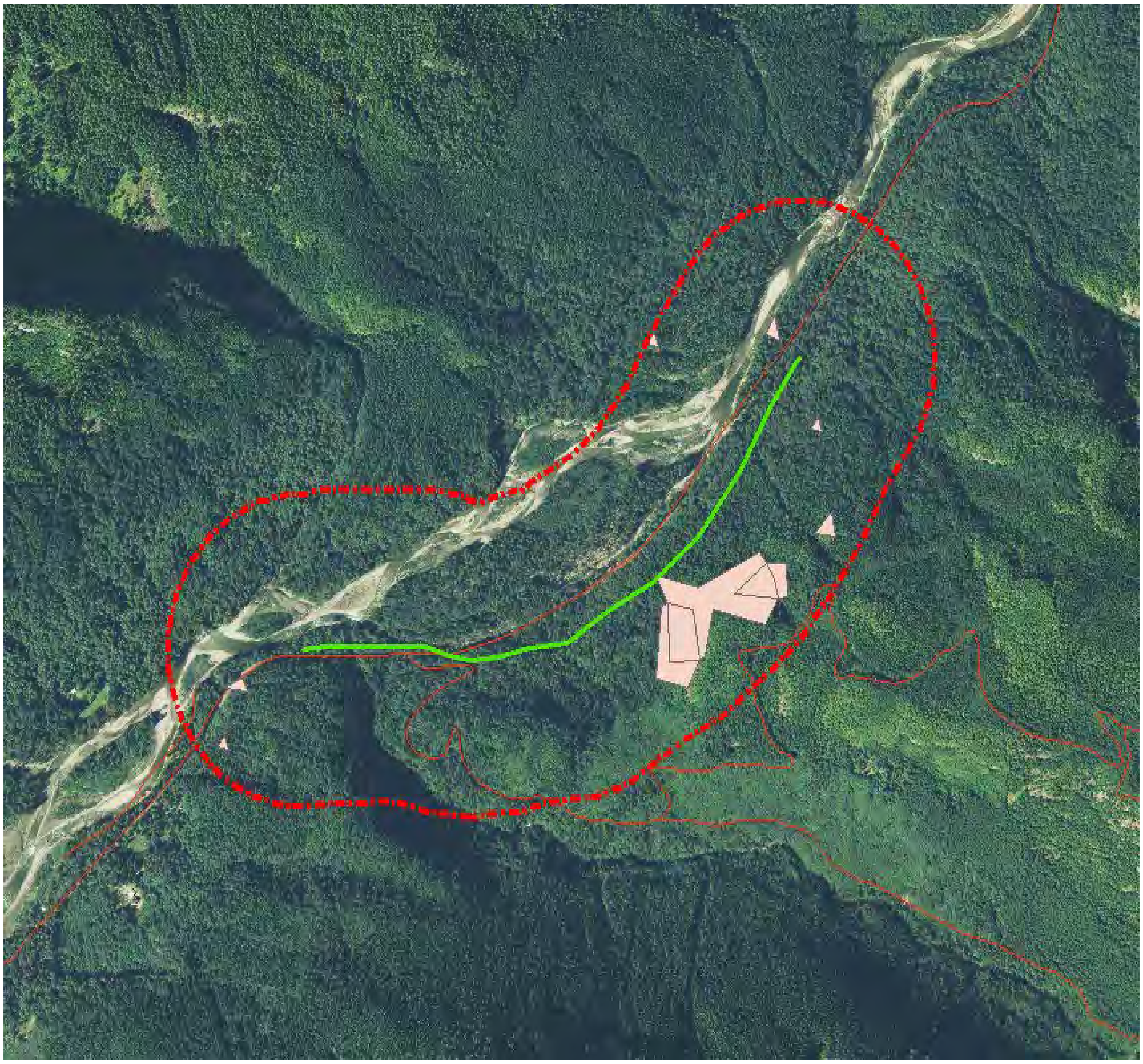

Figure 12. Screenshot depicting habitat suitability data, including small patches of potential habitat within 0.25 mile (approximately 18 acres)

Factors Responsible for the Condition of the Species

Appendix C (Status of the Species – Marbled Murrelet) describes conservation needs and threats to the species with a focus on Conservation Zones 1 and 2.

The Service has previously issued Opinions for actions adversely affecting marbled murrelets in Conservation Zones 1 and 2. The Service determined that each of these actions was not likely to jeopardize the continued existence of the marbled murrelet, and would not destroy or adversely modify designated marbled murrelet critical habitat. Nevertheless, the combined effects of these past and contemporaneous federal actions have resulted in short- and long-term adverse effects to the marbled murrelet and, in some instances, an incremental degradation of the environmental baseline.

Conservation Role of the Action Area

Lands considered essential for the recovery of the marbled murrelet within Conservation Zones 1 and 2 include: 1) any suitable habitat in a LSR; 2) all suitable habitat located in the Olympic Adaptive Management Area; 3) large areas of suitable nesting habitat outside of LSRs on federal lands; 4) suitable habitat on State lands within 40 miles of the coast; and 5) habitat within occupied marbled murrelet sites on private lands (USFWS 1997, pp. 131-134).

Climate Change

In the Pacific Northwest, mean annual temperatures rose 0.8 degrees C (1.5 degrees F) in the 20th century and are expected to continue to warm from 0.1 to 0.6 degrees C (0.2 to 1 degrees F) per decade (Mote and Salathe 2010, p. 29). Climate change models generally predict warmer, wetter winters and hotter, drier summers and increased frequency of extreme weather events in the Pacific Northwest (Salathe et al. 2010, pp. 72-73). Predicted climate changes in the Pacific Northwest have implications for forest disturbances that affect the quality and distribution of marbled murrelet habitat. Both the frequency and intensity of wildfires and insect outbreaks are expected to increase over the next century in the Pacific Northwest (Littell et al. 2010, p. 130).

One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration, and severity. Westerling et al. (2006, pp. 940-941) analyzed wildfires and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period from 1970-1986. The total area burned is more than 6.5 times the previous level and the average length of the fire season during 1987-2003 was 78 days longer compared to 1978-1986 (Westerling et al. 2006, p. 941). The area burned annually by wildfires in the Pacific Northwest is expected to double or triple by the 2080s (Littell et al. 2010, p. 140). Wildfires are now the primary cause of marbled murrelet habitat loss on Federal lands, with over 21,000 acres of habitat loss attributed to wildfires from 1993 to 2012 (Raphael et al. 2015b, p. 123). Climate change is likely to further exacerbate some existing threats such as the projected potential for increased habitat loss from drought related fire, mortality, insects and disease, and increases in extreme flooding, landslides and windthrow events in the short-term (10 to 30 years).

Within the marine environment, effects on the food supply (amount, distribution, quality) provide the most likely mechanism for climate change impacts to marbled murrelets. Studies in British Columbia (Norris et al. 2007) and California (Becker and Beissinger 2006) have documented long-term declines in the quality of prey, and one of these studies (Becker and Beissinger 2006, p. 475) linked variation in coastal water temperatures, prey quality during pre-breeding, and reproductive success. These studies indicate that marbled murrelet recovery may be affected as long-term trends in ocean climate conditions affect prey resources and marbled murrelet reproductive rates. While seabirds such as the marbled murrelet have life-history strategies adapted to variable marine environments, ongoing and future climate change could present changes of a rapidity and scope outside their adaptive range (USFWS 2009, p. 46).

EFFECTS OF THE ACTION: Bull Trout and Designated Bull Trout Critical Habitat

The effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The FHWA, WSDOT, and County propose to relocate an approximately one half-mile (0.5 mile) section of Index-Galena Road that lies within the CMZ of the North Fork Skykomish River. The proposed project will result in most of the roadway section being relocated away from the left-bank side channel to the mainstem North Fork Skykomish River, away from the CMZ, and above the 100-year floodplain.

Portions of the new alignment, from Station 34+50 to 45+50 and from Station 48+00 to 54+00 (a total distance of approximately 1,700 linear ft or 0.32 mile), will require construction of buried rock revetments at the periphery of the CMZ (approximately 10,000 cubic yards of large rock). Close proximity to the CMZ when tying back into the existing alignment will require toe protection in the event of further lateral migration of the active channel. A new 180-ft bridge will be constructed at the stream crossing near Station 54+00. The bridge will maintain and improve hydraulic connectivity with the North Fork Skykomish River, and preserve seasonal pool habitat and refugia. The new alignment and proposed features, including the buried rock revetments and 180-ft bridge, will reduce impediments to flood flow conveyance, and improve storage and attenuation of flood flows.

Existing damaged roadway sections along the old alignment will be decommissioned and removed, and the footprint restored where feasible with riparian plantings. Once the decommissioned roadway sections are removed, the FHWA, WSDOT and County will prepare the site for native plantings. On-site riparian buffer mitigation, consisting of enhancement and restoration with native plantings, will restore a forested corridor adjacent to the North Fork Skykomish River. Approximately 1,750 native shrubs and trees meeting USFS requirements and specifications will be planted to restore 1 acre of riparian buffer throughout the abandoned alignment. Habitat structures, including standing snags, brush piles, fallen trees, and stumps, will be placed throughout the restored riparian buffer. Some amount of off-site compensatory mitigation will be required. Off-site mitigation will consist of credits purchased at an established mitigation bank (FHWA, WSDOT, and Snohomish County 2016, p. 54). WSDOT and the County will purchase credits at the Skykomish Habitat Mitigation Bank as compensation for permanent impacts and loss of approximately 3.3 acres of riparian buffer.

Roadway fill and debris will be removed from the left-bank side channel and CMZ where it is safe and practicable to do so. Some of the debris has been substantially buried, or eroded by river flows and carried off-site. Where possible, ballasted or anchored large wood will be installed to provide and improve channel roughness and instream habitat complexity. Large wood will be installed along the waterward face of the buried rock revetments to “soften” the interface at the waterward edge of the rock toe scour protection.

The proposed project will improve floodplain conditions by restoring floodplain connectivity that historically has been impeded by the existing roadway alignment. The WSDOT and County also expect that moving the roadway further landward and removing roadway fill and debris from the CMZ will reduce future flood hazard risk. Floodplain connectivity will be restored to more than 200,000 ft^2 (4.6 acres) of floodplain.

Construction will require a minimum of two construction seasons and could extend to three seasons depending on sequencing and contingencies. Due to the remote location of the project and expected difficult construction conditions, the WSDOT and County plan to complete all or nearly all of the work between April and October. Construction of the new alignment and proposed features will require substantial clearing and grading (11.5 to 12.2 acres); between 8.3 acres and 8.9 acres will be restored at project completion with native plantings.

In-water work along approximately 350 linear ft of the proposed buried rock revetment may require work area isolation with the placement of a temporary cofferdam or bypass (approximately 7,000 ft^2; 350 ft x 20 ft). The WSDOT and County will implement standard WSDOT Fish Exclusion Protocols and Standards. Construction of the new 180-ft bridge will require little or no in-water work, but may require a temporary bridge span placed on earth, rock, or ecology block foundations and fills. Non-fish bearing streams located on moderate to steep slopes may be temporarily spanned or bypassed. All temporary and final culvert installations will have outlet protection to prevent downslope erosion and headcutting. Culverts will be sized to accommodate and convey the 100-year storm event.

Approximately 8,000 ft^2 of asphalt and roadway debris will be removed from approximately a half-dozen locations below the OHWM. Equipment will gain access to complete the work from remaining portions of the old road prism, and with the possible temporary placement of timber cribbing and crane mats. Equipment may also traverse and work from exposed channel bars. Approximately 5,000 ft^2 below the OHWM will be enhanced with large wood installations.

The FHWA, WSDOT, and County have proposed conservation measures to avoid and reduce impacts during construction (Snohomish County Public Works 2015, pp. 10, 13, 14; FHWA, WSDOT, and Snohomish County 2016, pp. 49, 50, 54, 55, 59, 60, 67-69). These conservation measures will avoid and reduce exposures and effects to bull trout and their habitat.

Summary

The Service expects that the proposed action will result in both direct and indirect effects to the bull trout and designated bull trout critical habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be long-term, lasting for the functional life of the constructed features. Our analysis specifically addresses the following potential adverse exposures and effects, as well as any effects associated with interrelated and interdependent actions:

- Stress and/or injury resulting from fish capture and handling operations.

- Exposure to construction activities and resulting direct effects. Construction activities will directly affect instream habitat that supports bull trout. Adult, subadult, and juvenile bull trout will be temporarily exposed to elevated levels of turbidity and sedimentation.

- Permanent and temporary effects to instream habitat structure, function, and diversity. The proposed action will reduce a significant, long-standing constraint on the CMZ, and restore channel-forming processes and floodplain and riparian processes that contribute to the creation and maintenance of complex instream habitat. However, the proposed action also includes the construction of buried rock revetments at the periphery of the CMZ (approximately 10,000 cubic yards of large rock, plus large wood; approximately 1,700 linear ft or 0.32 mile in total). We expect that these features will remain as a more or less permanent constraint on the CMZ, but will function better than smooth riprap revetments. Temporary effects to instream habitat resulting from channel response, during the months immediately following construction, will include significant bedload movements and resulting turbidity and sedimentation.

Construction activities have the potential to injure or kill a limited number of adult, subadult, and juvenile bull trout. Temporary exposures and effects to instream habitat may also significantly disrupt normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter). These exposures and effects may temporarily cause bull trout to avoid the action area, may impede or discourage free movement through the action area, prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions. Suitable bull trout spawning habitats are not present in the action area, and therefore the proposed action will have no effect on bull trout spawning habitat or essential spawning behaviors.

Insignificant and Discountable Effects

Some of the proposed action's potential effects to the bull trout and designated bull trout critical habitat will be insignificant or discountable. With implementation of the proposed conservation measures and permanent design elements, the Service concludes that the following potential effects are extremely unlikely to occur (discountable) or will not be measurable or detectable (insignificant):

- Direct effects (i.e., disturbance) to bull trout spawning behaviors and redds/eggs/alevins;

- Exposure to chemical contamination during construction;

- Effects to prey resources and the bull trout prey base;

- Stormwater effects;

- Long-term effects to floodplain and riparian processes, including large wood recruitment.

Construction activities will result in direct impacts to approximately 20,000 ft^2 (0.46 acre) below the OHWM of the North Fork Skykomish River. Turbidity and sedimentation resulting from construction activities will travel as far as 300 ft downstream, and temporary effects to instream habitat may extend as far as 0.25 mile downstream. Despite the large area affected by construction activities, direct effects to bull trout spawning and redds/eggs/alevins are considered extremely unlikely and therefore discountable. The nearest known bull trout spawning habitat is located in Salmon Creek, outside of the action area and at higher elevations. Therefore, bull trout spawning habitats will not be affected, either directly or indirectly. The aquatic component of the action area encompasses spawning habitats used annually by Chinook and steelhead salmon, but local, expert knowledge of the area indicates no history of bull trout spawning.

Construction will require one or more pieces of heavy equipment to enter and operate below the OHWM of the North Fork Skykomish River. However, except for the purposes of gaining access to and removing asphalt and roadway debris from below the OHWM, heavy equipment will operate from positions above and/or landward of the wetted channel (including temporary fills, timber cribbing, and crane mats). Heavy equipment may also operate within the work area isolated with a temporary cofferdam or bypass (i.e., when constructing approximately 350 linear ft of the proposed buried rock revetment).

A release of harmful materials (e.g., fuel, lubricants, hydraulic fluid) is possible, but extremely unlikely. The FHWA, WSDOT, and County will implement an Engineer-approved SPCC plan to guard against the release of any harmful pollutant or product. Any equipment entering the water will use vegetable oil or another biodegradable hydraulic fluid substitute, and no oils, fuels, cleaning agents or solvents, concrete or equipment wash water, slurry, waste, or construction debris will be discharged to surface waters or onto land with a potential to reenter surface waters. With successful implementation of the proposed conservation measures, effects to the bull trout and designated bull trout critical habitat resulting from exposure to chemical contamination during construction are considered extremely unlikely and therefore discountable.

Construction activities will result in direct impacts to approximately 20,000 ft^2 (0.46 acre) below the OHWM of the North Fork Skykomish River. Turbidity and sedimentation resulting from construction activities will travel as far as 300 ft downstream, and temporary effects to instream habitat may extend as far as 0.25 mile downstream. Despite the large area directly and indirectly affected, we expect that temporary effects to prey resources and the bull trout prey base will not be measurable, and are therefore considered insignificant. The action area supports populations of Chinook, steelhead, and other native fishes, which together provide a sizable prey base for bull trout. There are no indications that either terrestrial organisms or aquatic macroinvertebrates are lacking. The food base is not a limiting factor within the action area, and the effects of the action will not measurably diminish the availability of prey in either the short- or long-term.

The proposed action will use flow dispersion and infiltration as the preferred means to control and treat stormwater runoff. Concentrating stormwater runoff will be avoided to the maximum extent practicable. Consistent with the requirements of the WSDOT Highway Runoff Manual, additional flow control and/or treatment BMPs will be implemented where warranted and practicable. With full and successful implementation of the proposed conservation measures and permanent design elements, foreseeable long-term and indirect stormwater effects will be insignificant.

The proposed action will have significant, unavoidable temporary impacts to riparian buffers associated with 11.5 to 12.2 acres of clearing and grading. However, the proposed action will also: 1) restore and re-establish at least 1 acre of riparian buffer throughout the abandoned alignment, 2) restore and enhance riparian function with native plantings across more than 8 acres of the temporary footprint (including stabilized side slopes), and 3) mitigate off-site with the purchase of credits at an established mitigation bank for the permanent impacts and loss of approximately 3.3 acres of riparian buffer. Furthermore, by relocating most of the roadway section away from the North Fork Skykomish River and CMZ, by restoring connectivity to more than 4.6 acres of floodplain, and by installing large wood along the buried rock revetments and in the restored riparian buffers, the proposed action will avoid permanent adverse effects to riparian functions.

The proposed action will restore connectivity across more than 200,000 ft^2 (4.6 acres) of floodplain, reduce impediments to flood flow conveyance, and improve the storage and attenuation of flood flows. The action will improve connectivity with the North Fork Skykomish River for small watercourses, preserve seasonal pool habitat and refugia, and install ballasted or anchored large wood to provide and improve channel roughness and instream habitat complexity. Finally, the proposed action includes large wood installed along the waterward face of the buried rock revetments to “soften” the interface at the waterward edge of the rock toe scour protection.

The proposed action will reduce a significant, long-standing constraint on the CMZ, and restore channel-forming processes and floodplain and riparian processes that contribute to the creation and maintenance of complex instream habitat. With full and successful implementation of the proposed conservation measures and permanent design elements, and considering their position and proximity to the North Fork Skykomish River, the Service concludes that the action’s foreseeable long-term effects to floodplain and riparian processes (including large wood recruitment) will be beneficial. The proposed action will enhance and not degrade floodplain and riparian functions and processes.

Effects Resulting from Fish Capture and Handling

In-water work along approximately 350 linear ft of the proposed buried rock revetment may require work area isolation with the placement of a temporary cofferdam or bypass (approximately 7,000 ft^2; 350 ft x 20 ft). The WSDOT and County will implement standard WSDOT Fish Exclusion Protocols and Standards.

All work below the OHWM will be completed during the approved in-water work window (August 1 to August 31), and will comply with the Hydraulic Project Approval issued for the project by the WDFW. Any pumps used to temporarily bypass water or to dewater residual pools will be screened at the intake. Fish screens or guards will comply with Washington State law (RCW 77.57.010 and 77.57.070), with guidelines prescribed by the NMFS, and any more stringent requirements contained in permits issued for the project by the WDFW. Pumps will not be operated without a screened intake unless there is no risk of entraining fish, and there are adequate plans in place to address contingencies (including a routine schedule for inspection). Work will not inhibit fish passage during or after construction.

Work area isolation, flow diversion, and partial dewatering are conservation measures intended to reduce the risk of fish stranding and other forms of injury (e.g., exposure to intense turbidity). The FHWA, WSDOT, and County will implement these practices to avoid the more severe effects that bull trout might experience from remaining within the work area.

It is possible that a limited number of bull trout may be injured or killed when capturing and removing fish from the work area. However, it is more likely that adverse effects to adult, subadult, or juvenile bull trout resulting from fish capture and handling will occur in the form of increased stress and a temporary disruption to their normal bull trout behaviors.

The WSDOT's Fish Exclusion Protocols and Standards require that the fish capture operation be conducted by or under the supervision of an experienced biologist, and that all staff participating in the operation must have the necessary knowledge, skills, and abilities to ensure safe handling of fish. WSDOT protocols require that the fish capture operation must have proper equipment on-hand (e.g., buckets, aerators, etc.) and take appropriate steps to minimize the amount and duration of handling. The protocols require that captured fish be released to flowing waters in close proximity, in areas that offer adequate cover and suitable temperature and water quality conditions, as quickly as is practicable.

Electrofishing will be employed only as a last resort, after all other means of fish capture and removal have been exhausted (e.g. herding with block nets, seining, dip nets in conjunction with dewatering, etc.), and only after a qualified biologist determines that all or nearly all of the adult and subadult-sized fish have been effectively removed. Only biologists trained by qualified personnel and familiar with equipment handling, settings, maintenance, and safety may operate electrofishing equipment. Capture operations that utilize electrofishing equipment shall use the minimum voltage, pulse width, and rate settings necessary to immobilize fish, and shall measure water conductivity in the field before electrofishing in order to determine appropriate settings.

Electrofishing is typically used as a last resort to remove fish. The process involves passing an electrical current through water to immobilize fish and facilitate their capture and removal from the in-water work area. The process of running an electrical current through the water can cause a range of effects, including annoyance, startle, or avoidance behavior; temporary immobility; physical injury; and, mortality. The amount of unintentional (or incidental) injury or mortality attributable to electrofishing can vary widely, depending upon the equipment used, settings used, site conditions (e.g., clarity of water and visibility), and the expertise of the operator. Accidental contact with the electrodes is a frequent cause for physical injury or mortality. When fish capture operations use the minimum voltage, pulse width, and rate settings necessary to immobilize fish, shocked fish normally revive quickly.

Electrofishing can more severely affect adult salmonids because of their larger size and surface area. Injuries, which may cause or contribute to delayed mortality, can include spinal hemorrhages, internal hemorrhages, fractured vertebra, spinal misalignment, and separated spinal columns (Dalbey et al. 1996; Hollender and Carline 1994; Thompson et al. 1997b). Sharber and Carothers (1988) report that electrofishing killed 50 percent of the adult rainbow trout in their study. The long-term effects of electrofishing on juvenile and adult salmonids are not well understood, but long experience with electrofishing indicates that most measurable effects occur at the time of fish capture operations and are of relatively short duration.

Most studies on the effects of electrofishing have been conducted on adult fish greater than 300 millimeters in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988), and may therefore experience lower injury rates (Dalbey et al. 1996; Thompson et al. 1997a; Thompson et al. 1997b). McMichael et al. (1998) found a 5.1 percent injury rate for juvenile steelhead captured by electrofishing in the Yakima River.

The incidence and severity of electrofishing injury is partly related to the type of equipment used and the waveform produced (Dalbey et al. 1996; Dwyer and White 1997; Sharber and Carothers 1988). Continuous direct current or low-frequency pulsed direct current (equal or less than 30 Hz) have been recommended for electrofishing because lower spinal injury rates, particularly in salmonids, have resulted from these waveforms (Dalbey et al. 1996).

Only a few studies have examined the long-term effects of electrofishing on salmonid survival and growth (Ainslie et al. 1998; Dalbey et al. 1996). These studies indicate that although some fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes exhibit no growth at all (Dalbey et al. 1996).

Adult and subadult salmonids, because of their larger size (i.e., older than one year and larger than 150 mm; with variation dependent on species), cannot seek refuge in gravels and are generally easier to detect, herd, seine, and/or net. Therefore, fish capture operations that exhaust other means of capture (e.g. herding with block nets, seining, dip nets in conjunction with dewatering, etc.) should not generally expose many adult or subadult salmonids to the added risks associated with electrofishing. However, some adults and subadults may hide under vegetation or other cover (e.g., cut banks, rootwads, etc.). While herding, seining, and netting are much safer means by which to capture and remove fish (i.e., they present lower risks of injury and/or incidental mortality), all forms of capture and handling contribute some degree of stress and otherwise disrupt normal behaviors (i.e., the ability to successfully feed, move and/or shelter).

The Service expects that with careful, full implementation of the proposed conservation measures, and considering the small size of the area(s) where fish capture operations will or may be conducted, a very modest number of juvenile, subadult, and adult bull trout may be affected by fish capture and handling. All, or nearly all, of the subadult and adult bull trout should be effectively removed prior to electrofishing, and the rate of injury and/or accidental (incidental) mortality should be low for juvenile, subadult, and adult bull trout. It is more likely that adverse effects to juvenile, subadult, or adult bull trout resulting from fish capture and handling will take the form of increased stress and a temporary disruption to their normal bull trout behaviors. While this added stress and disruption to their normal behaviors will have measurable short-term effects (including interruption to feeding and increased energetic demands), we expect that all, or nearly all, of the exposed individuals will experience no long-term effects.

Applying best professional judgment, and with consideration for the timing and location of construction activities, the amount and quality of affected habitat, methods for work area isolation and dewatering, and WSDOT's Fish Exclusion Protocols and Standards, the Service expects that no more than one adult or subadult bull trout, and one juvenile bull trout will suffer physical injury or mortality. The Service concludes that no more than two adult or subadult bull trout, and three juvenile bull trout will suffer a disruption to their normal behaviors and/or stress as a result of fish capture and handling.

Exposure to Elevated Turbidity and Sedimentation During Construction

Construction activities will result in direct impacts to approximately 20,000 ft^2 (0.46 acre) below the OHWM of the North Fork Skykomish River. Construction activities with the potential to cause significant temporary increases in turbidity and sedimentation include 1) excavation and removal of roadway fill and debris from accessible locations below the OHWM, 2) placement of ballasted or anchored large wood below the OHWM, and 3) the placement (and subsequent removal) of a temporary cofferdam or bypass in conjunction with work area isolation and construction of the proposed buried rock revetment. However, with a footprint that includes approximately 12 acres of clearing and grading on steep side slopes (i.e., moderately steep to very steep side slopes), we also acknowledge that some work completed in the uplands (e.g., installation of culverts on moderate to steep slopes) may become a source of turbidity and sedimentation further downslope.

Based upon the nature of the proposed work, the size, volume, and morphology of the North Fork Skykomish River within the action area, and the conditions likely to prevail during construction of the project, we expect that turbidity and sedimentation resulting from construction activities will travel as far as 300 ft downstream before concentrations are diminished by dilution and deposition to levels that are difficult to distinguish from background/ ambient concentrations. Temporary increases in turbidity resulting from construction may significantly disrupt normal bull trout behaviors (feeding, moving, and sheltering), and may create a temporary barrier to free movement and migration.

Although few studies have specifically examined the issue as it relates to bull trout, increases in suspended sediment affect salmonids in several recognizable ways. The variety of effects of suspended sediment may be characterized as lethal, sublethal, or behavioral (Bash et al. 2001, p. 10; Newcombe and MacDonald 1991, pp. 72-73; Waters 1995, pp. 81-82). Lethal effects include gill trauma (physical damage to the respiratory structures) (Curry and MacNeill 2004, p. 140) and smothering and other effects that can reduce egg-to-fry survival (Chapman 1988, pp. 12-16). Sublethal effects include physiological stress reducing the ability of fish to perform vital functions (Cederholm and Reid 1987, pp. 388, 390), severely reduced respiratory function and performance (Waters 1995, p. 84), increased metabolic oxygen demand (Servizi and Martens 1991, p. 497), susceptibility to disease and other stressors (Bash et al. 2001, p. 6), and reduced feeding efficiency (Newcombe and MacDonald 1991, p. 73). Sublethal effects can act separately or cumulatively to reduce growth rates and increase fish mortality over time. Behavioral effects include avoidance, loss of territoriality, and related secondary effects to feeding rates and efficiency (Bash et al. 2001, p. 7). Fish may be forced to abandon preferred habitats and refugia, and may enter less favorable conditions and/or be exposed to additional hazards (including predators) when seeking to avoid elevated concentrations of suspended sediment.

In order to assess the suspended sediment concentrations at which adverse effects will occur and to determine the downstream extent to which these effects may extend as a result of the proposed project, we used the analytical framework attached as Appendix E (USFWS 2010). This framework uses the findings of Newcombe and Jensen (1996) to evaluate the “severity-of-effect” based on suspended sediment concentration, exposure, and duration. Factors influencing suspended sediment concentration, exposure, and duration include waterbody size, volume of flow, the nature of the construction activity, construction methods, erosion controls, and substrate and sediment particle size. Factors influencing the severity-of-effect include duration and frequency of exposure, concentration, and life stage. Availability and access to refugia are other important considerations.

The framework in Appendix E requires an estimate of suspended sediment concentration (mg/L) and exposure duration. Monitoring data collected on the Skykomish River at Monroe (Station No. 07C070) were used to determine the ratio of turbidity to suspended solids for the waterbody (1 NTU : 1.94 mg/L). To determine exposure duration, we assumed that work below the OHWM would occur 10 hours a day, for as many as 60 working days (two in-water construction seasons; August 1 to August 31). It is important to note we expect that any measurable increases in turbidity will be short-term and episodic.

Using this approach, we expect that adverse effects to adult, subadult, and juvenile bull trout are likely to occur under the following circumstances:

1. When background NTU levels are exceeded by 50 NTUs at any point in time.

2. When background NTU levels are exceeded by 20 NTUs for more than 1 hour, continuously.

3. When background NTU levels are exceeded by 10 NTUs for more than 3 hours, cumulatively, over a 10-hour workday.

4. When background NTU levels are exceeded by 5 NTUs for more than 7 hours, cumulatively, over a 10-hour workday.

To assess the potential extent of these effects we relied on a limited set of monitoring data collected to determine the effectiveness of BMPs and compliance with State surface water quality standards. We also considered the nature and extent of the proposed in-water work, and the North Fork Skykomish River’s seasonal hydrological conditions. Based on this information, we expect that suspended sediment concentrations resulting in adverse effects to bull trout are reasonably certain to occur as far as 300 ft downstream of construction activities.

We expect that a modest number of adult, subadult, and juvenile bull trout will be in the action area at the time of construction and may be exposed to elevated turbidity and sedimentation. We expect that some bull trout will avoid the area when elevated suspended sediment concentrations result from construction activities. Resulting turbidities may also impede or discourage free movement through the action area, and combined with other aspects of construction in and around the channel (including flow diversion), may delay or discourage adult bull trout from migrating up through and around the project area. However, bull trout will not be exposed to elevated turbidities outside daylight hours, and therefore nocturnal movements and migration through and around the project area will be unimpeded.

Temporary increases in turbidity may prevent individuals from exploiting preferred habitats, and/or expose individuals to less favorable conditions. We expect that elevated turbidity and sedimentation extending as far as 300 ft downstream of construction activities will result in a significant temporary disruption of normal bull trout behaviors (i.e., ability to successfully feed, move, and/or shelter).

Permanent and Temporary Effects to Instream Habitat

The Service expects that the proposed action will result in both direct and indirect effects to bull trout rearing and FMO habitats. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be permanent or long-term, lasting for the functional life of the constructed features.

The proposed action will reduce a significant, long-standing constraint on the CMZ, and restore channel-forming processes and floodplain and riparian processes that contribute to the creation and maintenance of complex instream habitat. However, the proposed action will also construct buried rock revetments at the periphery of the CMZ (approximately 10,000 cubic yards of large rock, plus large wood; approximately 1,700 linear ft or 0.32 mile in total). The Service expects that these features will remain as a more or less permanent constraint on the CMZ, but will function better than smooth riprap revetments. Temporary effects to instream habitat resulting from channel response, during the months immediately following construction, will include significant bedload movements and resulting turbidity and sedimentation.

<u>Temporary Effects to Instream Habitat</u>

Temporary effects to instream habitat will result from channel response to the constructed features during the months immediately following construction. When activated under high flow events, the constructed features may have pronounced, localized effects on flow velocities, bed shear stress, and patterns of sediment transport and channel bed formation.

We expect that channel response and temporarily altered patterns of sediment transport will cause a measurable increase in sedimentation along the downstream reach, extending as far as 0.25 mile downstream. Sediments deposited along the downstream reach may accumulate in pools or tailouts, and may for a time bury some of the native substrates. These temporary effects to instream habitat may reduce foraging and overwintering opportunities for individual bull trout (juveniles in particular). However, we expect these effects will be limited in both physical extent and duration. We expect that within the action area the channel will adjust and resume natural patterns of bedload and sediment transport within two years of construction.

Increased sedimentation along the downstream reach will temporarily degrade bull trout rearing and FMO habitat. We expect that measurable increases in sedimentation will significantly disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and/or shelter) to a distance of 0.25 mile, and for a duration of up to two years.

<u>Permanent Effects to Instream Habitat</u>

The proposed action will reduce, but not permanently eliminate, a long-standing constraint on the North Fork Skykomish River's CMZ. Buried rock revetments constructed at the periphery of the CMZ will remain as a permanent feature along approximately 1,700 linear ft. Bank hardening will reduce opportunities for interaction between the active channel and floodplain, will permanently (or indefinitely) reduce the potential for development of off-channel habitat complexity, and impair natural processes that contribute to the formation and maintenance of diverse instream habitats.

However, the proposed action incorporates permanent design elements which we expect will partially offset these adverse effects. The buried rock revetments will incorporate a significant amount of large wood, creating bank roughness and complex habitat at the periphery of the CMZ. Furthermore, we expect that because these features will resist erosion and maintain structural integrity even with some amount of settling and deformation, the proposed action will avoid the environmental damage that might otherwise result from repetitive future roadway repairs. The Service expects that the constructed features will function better over time than a smooth riprap revetment.

Bank hardening impairs the natural processes that contribute to the formation and maintenance of diverse instream habitats. The adverse effects of bank hardening are well documented in the scientific literature. The extensive bank hardening that has occurred along the lower Sacramento River provides one good, thoroughly investigated example (USFWS 2000). The adverse effects of bank hardening can include: 1) Interruption of the dynamic equilibrium, which through patterns of erosion and sedimentation contributes, sorts, and distributes substrates of varying size within the active channel migration zone; 2) Uncoupling of the active channel and riparian zones, reducing the frequency of overbank flows and recruitment of large wood; 3) Confinement of the CMZ, reducing or eliminating opportunities for meander migration and development of off-channel habitat; and, 4) Straightening of the active channel and reduction in bank roughness, leading to intensification of water velocities and forces which cause channel incision and accelerated rates of bank erosion upstream and downstream of the hardened bank (Schmetterling *et al*. 2001; USFWS 2000). These effects impair the natural processes that contribute to the formation and maintenance of diverse instream physical habitat.

Bank hardening most acutely affects the diversity of channel margin and off-channel habitats. Microhabitats in the form of point bars, backwaters and eddies, undercut banks, debris jams, side channels, oxbows, and overhanging bank vegetation are generally all substantially reduced as a result of bank hardening and channel confinement (Schmetterling *et al*. 2001; USFWS 2000). Furthermore, with decoupling of the natural processes and interactions within the floodplain, systems lose their ability to replace and repair degraded habitats.

The proposed action will harden approximately 1,700 linear ft of the North Fork Skykomish River's left-bank side channel. In doing so, the action will reduce the opportunity for meander migration and further development of off-channel habitats. The proposed action will have significant indirect effects, occurring later in time but persisting for the functional life of the constructed features. These indirect effects include a reduced incidence of overbank flows and interrupted patterns of erosion, sedimentation, and recruitment of large wood. Were it not for the inclusion of permanent design elements that partially offset these adverse effects, we would expect simplified and homogenized instream structure to result in time along the affected bank.

The Service expects that the proposed action will maintain a diverse and complex assemblage of instream habitats along the affected reach, including a range of channel depths, complex cover, and resting and refuge habitat from stream velocities and forces. We expect that the resulting conditions will provide good rearing, foraging, and overwintering opportunities for bull trout.

Outside the limits of the constructed features, we do not expect that the proposed action will have measurable adverse effects to bull trout habitat. The action will restore floodplain connectivity to more than 200,000 ft^2 (4.6 acres) of floodplain, reduce impediments to flood flow conveyance, and improve the storage and attenuation of flood flows. The proposed action should increase channel and floodplain roughness, and thereby lessen hydraulic forces and resulting bed and bank erosion along the downstream reach. The Service acknowledges that the constructed features will or may have measurable effects to bedload movement, large wood transport and accumulation, and channel formation along the downstream reach.

The Service does not expect that engineered bank treatments will function exactly as intended, or indefinitely, in all cases. Therefore, the proposed action does present some potential risk for future adverse effects to the bull trout. The proposed action will eliminate the opportunity for meander migration and further development of off-channel habitats along approximately 1,700 linear ft of the North Fork Skykomish River's left-bank side channel. In doing so, the proposed action will reduce rearing, foraging, and overwintering opportunities for individual bull trout (juveniles in particular). Therefore, the Service expects that the proposed action will have measurable, adverse effects to bull trout along 1,700 linear ft of the North Fork Skykomish River, indefinitely and for the functional life of the constructed features.

Summary of Effects (Matrix of Pathways and Indicators)

An earlier section applied the Matrix of Diagnostics / Pathways and Indicators (USFWS 1998) as a tool for describing whether aquatic habitat is properly functioning, functioning at risk, or functioning at unacceptable levels of risk at the scale of the action area. Table 3 summarizes the effects of the proposed action using this same matrix. For a fuller description of the anticipated effects of the action see the preceding sub-sections.

Table 3. Effects of the action ("Matrix of Pathways and Indicators").

Pathway	Indicator	Baseline Conditions	Effect of the Action
Water Quality	Temperature	Functioning Adequately	Maintain
	Sediment	Functioning Adequately	**Degrade** (Temporary)
	Chemical Contamination & Nutrients	Functioning Adequately	Maintain
Habitat Access	Physical Barriers	At Risk	Maintain
Habitat Elements	Substrate	Functioning Adequately	**Degrade** (Temporary)
	Large Woody Debris	Functioning Adequately	Maintain
	Pool Frequency / Quality	Functioning Adequately	Maintain
	Large Pools	Functioning Adequately	Maintain
	Off-Channel Habitat	At Risk	**Degrade**
	Refugia	At Risk	Maintain
Channel Conditions & Dynamics	Width/Depth Ratio	At Risk	Maintain
	Streambank Condition	At Risk	Maintain
	Floodplain Connectivity	Unacceptable Risk	**Restore**
Flow / Hydrology	Peak / Base Flows	At Risk	Maintain
	Drainage Network	At Risk	Maintain
Watershed Conditions	Road Density / Location	Unacceptable Risk	**Restore**
	Disturbance History	At Risk	Maintain
	Riparian Reserve	At Risk	Maintain

Effects to the PCEs of Designated Bull Trout Critical Habitat

An earlier section identified the PCEs that define designated bull trout critical habitat and described their baseline condition in the action area. The following section discusses the effects of the proposed action with reference to the nine PCEs.

1) *Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.*

The proposed action will have no measurable effect on this PCE. Any temporary or permanent effect to this PCE will be insignificant. Within the action area, this PCE will retain its current level of function (not impaired).

2) *Migratory habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.*

The proposed action will have measurable adverse effects on this PCE. Construction activities may temporarily impair function of the migratory corridor during the course of in-water work. However, nocturnal movements and migration through and around the project area will be unimpeded.

The proposed action will have long-term beneficial effects on this PCE. The proposed action will not create or contribute to any existing impediments to migration, but will instead reduce a significant, long-standing constraint on the CMZ, and restore channel-forming processes and floodplain and riparian processes that contribute to the creation and maintenance of complex instream habitat. Within the action area, this PCE will achieve an enhanced level of function, but will remain moderately impaired.

3) *An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

The proposed action will have no measurable effect on this PCE. Any temporary or permanent effect to this PCE will be insignificant. Within the action area, this PCE will retain its current level of function (mildly impaired).

4) *Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates, to provide a variety of depths, gradients, velocities, and structure.*

The proposed action will have both beneficial effects and adverse effects on this PCE. The action will reduce a significant, long-standing constraint on the CMZ, and restore channel-forming processes and floodplain and riparian processes that contribute to the creation and maintenance of complex instream habitat. However, the proposed action will also harden approximately 1,700 linear ft of the North Fork Skykomish River's left-bank side channel. In doing so, the action will reduce the opportunity for meander migration and further development of off-channel habitats.

The proposed action will have significant, unavoidable temporary impacts to riparian buffers associated with 11.5 to 12.2 acres of clearing and grading. However, the proposed action will also: 1) restore and re-establish at least 1 acre of riparian buffer throughout the abandoned alignment, 2) restore and enhance riparian function with native plantings across more than 8 acres of the temporary footprint (including stabilized side slopes), and 3) mitigate off-site with the purchase of credits at an established mitigation bank for the permanent impacts and loss of approximately 3.3 acres of riparian buffer. Furthermore, by relocating most of the roadway section away from the North Fork Skykomish River and CMZ, by restoring connectivity to more than 4.6 acres of floodplain, and by installing large wood along the buried rock revetments and in the restored riparian buffers, the proposed action will avoid permanent adverse effects to riparian functions.

The proposed action will restore floodplain connectivity to more than 200,000 ft^2 (4.6 acres) of floodplain, reduce impediments to flood flow conveyance, and improve the storage and attenuation of flood flows. This should reduce hydraulic forces and resulting bed and bank erosion.

The proposed action will have significant indirect effects, occurring later in time but persisting for the functional life of the constructed features. These indirect effects include a reduced incidence of overbank flows and interrupted patterns of erosion, sedimentation, and recruitment of large wood. Were it not for the inclusion of permanent design elements that partially offset these adverse effects, we would expect simplified and homogenized instream structure to result in time along the affected bank.

With full and successful implementation of the proposed conservation measures and permanent design elements, and considering their position and proximity to the North Fork Skykomish River, the Service concludes that the action's foreseeable long-term effects to floodplain and riparian processes (including large wood recruitment) will be beneficial. The proposed action will enhance and not degrade floodplain and riparian functions and processes. The Service expects that the action will maintain a diverse and complex assemblage of instream habitats along the affected reach, including a range of channel depths, complex cover, and resting and refuge habitat from stream velocities and forces. We expect that the resulting conditions will provide good rearing, foraging, and overwintering opportunities for bull trout.

Within the action area, this PCE will achieve an enhanced level of function, but will remain moderately impaired.

5) *Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shade, such as that provided by riparian habitat; and local groundwater influence.*

The proposed action will have no measurable effect on this PCE. Any temporary or permanent effect to this PCE will be insignificant. Within the action area, this PCE will retain its current level of function (not impaired).

6) *Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 mm (0.03 inch) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.*

Suitable bull trout spawning habitats are not present in the action area, and therefore the proposed action will have no effect on bull trout spawning habitats. The nearest documented bull trout spawning habitats are located in Salmon Creek, outside of the action area and at higher elevations. The proposed action will have no measurable temporary or permanent effect on this PCE. Within the action area, this PCE will retain its current level of function (mildly impaired).

7) *A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph.*

The proposed action will have no adverse effects on this PCE. The Service expects that the action will improve the storage and attenuation of flood flows and increase channel and floodplain roughness, thereby reducing hydraulic forces and resulting bed and bank erosion. Any permanent or long-term effect to this PCE will be insignificant and/or beneficial. Within the action area, this PCE will retain its current level of function (not impaired).

8) *Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.*

The proposed action will have measurable adverse effects on this PCE. Temporary, construction-related increases in turbidity may extend as far as 300 ft downstream of sediment generating activities. We expect that measurable, construction-related increases in turbidity will be short-term and episodic, but may occur at any time during the course of in-water work.

The Service expects periodic, post-construction pulses of turbidity and sedimentation, extending as far as 0.25 mile downstream. However, we expect these effects will be limited in both physical extent and duration. We expect that within the action area the channel will adjust and resume natural patterns of bedload and sediment transport within two years of construction.

The proposed action will have no measurable, permanent or long-term effect on this PCE. The proposed action will not permanently degrade or impair water quality or quantity within the action area. Within the action area, this PCE will retain its current level of function (not impaired).

9) *Few or no nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass; inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species present.*

The proposed action will have no measurable effect on this PCE. Any temporary or permanent effect to this PCE will be insignificant. Within the action area, this PCE will retain its current level of function (mildly impaired).

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action (USFWS and NMFS 1998).

The proposed action will have significant indirect effects to bull trout and designated bull trout critical habitat. The action will reduce, but not permanently eliminate, a long-standing constraint on the North Fork Skykomish River's CMZ. Buried rock revetments constructed at the periphery of the CMZ will remain as a permanent feature along approximately 1,700 linear ft. Indirect effects will include a reduced incidence of overbank flows and interrupted patterns of erosion, sedimentation, and recruitment of large wood. Were it not for the inclusion of permanent design elements that partially offset these adverse effects, we would expect simplified and homogenized instream structure to result in time along the affected bank.

The proposed action will incorporate a significant amount of large wood, creating bank roughness and complex habitat at the periphery of the CMZ. The action will restore floodplain connectivity to more than 200,000 ft^2 (4.6 acres) of floodplain, reduce impediments to flood flow conveyance, and improve the storage and attenuation of flood flows. The proposed action will increase channel and floodplain roughness, and thereby lessen hydraulic forces and resulting bed and bank erosion

The Service expects that the proposed action will maintain a diverse and complex assemblage of instream habitats along the affected reach, including a range of channel depths, complex cover, and resting and refuge habitat from stream velocities and forces. We expect that the resulting conditions will provide good rearing, foraging, and overwintering opportunities for bull trout. For a fuller discussion of these indirect effects, see the preceding sub-sections.

The proposed action will not result in changes in the use or function of the road infrastructure. The action will not construct new points of access or increase traffic or visitor capacity. No future development proposals or other major actions are contingent or dependent upon the proposed action. The Service expects that no discernible changes in the rate or pattern of land use conversion will result, in whole or in part, from the action. We also expect that no discernible changes in long-term public use or management will result from the proposed action. There are no other foreseeable indirect effects to bull trout or designated bull trout critical habitat that might occur later in time.

Effects of Interrelated and Interdependent Actions

Interrelated actions are defined as actions "that are part of a larger action and depend on the larger action for their justification;" interdependent actions are defined as actions "that have no independent utility apart from the action under consideration" (50 CFR section 402.02).

Construction will be staged from the existing roadway alignment. Other suitable, previously disturbed areas will be used to the fullest extent practicable. When removing asphalt and roadway debris from below the OHWM, heavy equipment will gain access to complete the work from remaining portions of the old road prism.

There are no other identifiable interrelated or interdependent actions. No measurable effects to bull trout individuals, their prey base, or habitat are expected to result from interrelated or interdependent actions.

EFFECTS OF THE ACTION: Marbled Murrelet

The effects of the action refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

Construction of the new alignment and proposed features will require substantial clearing and grading. The project area is estimated at 11.5 acres (FHWA, WSDOT, and Snohomish County 2016, p. 15) to 12.2 acres (Snohomish County Public Works 2015, p. 9). The clearing limits along the new roadway alignment will be logged. Between 8.3 acres (FHWA, WSDOT, and Snohomish County 2016, p. 15) and 8.9 acres (Snohomish County Public Works 2015, p.10) will be restored at project completion with native plantings.

Construction of the new roadway section will require removing large rock obstructions from at least 550 linear ft of the alignment (Snohomish County Public Works 2015, p. 9; Snohomish County Public Works 2016, pp. 1-4). Conventional earth moving equipment will be used in combination with hydraulic hammers (or hoe rams), and rock drilling and blasting to remove these large rock obstructions as they are encountered and construction progresses along the new alignment. A typical day removing large rock obstructions will include two or more hours of pre-drilling, followed by one or two controlled blasts, and two or more hours of additional work using hydraulic hammers and excavators (Snohomish County Public Works 2016, p. 1).

The FHWA, WSDOT, and County have proposed conservation measures to avoid and reduce impacts during construction (Snohomish County Public Works 2015, pp. 10, 13, 14; FHWA, WSDOT, and Snohomish County 2016, pp. 49, 50, 54, 55, 59, 60, 67-69). These conservation measures include the following, which we expect will avoid and reduce exposures and effects to marbled murrelets:

- Between April 1 and September 23, all work will start 2 hours after sunrise and stop 2 hours before sunset.

- The County will monitor replanted areas for 10 years to ensure mitigation success.

The terrestrial boundaries of the action area were defined based on the extent of temporary sound and visual disturbance that will result during construction. The Service has determined that temporary increased sound levels associated with routine construction activities are likely to exceed ambient, background sound levels to a distance of approximately 2,000 ft. However, sound levels resulting from blasting operations will attenuate to 70 dBA at a distance of approximately 1.5 miles, and to 92 dBA at a distance of approximately 0.2 mile. The terrestrial boundaries of the action area extend to a distance of at least 1.5 miles.

The surrounding landscape includes both deciduous dominated and mixed coniferous-deciduous forest. Within the project area and limits of construction these forested habitats consist mostly of mixed second growth stands located on rugged, steep, northwest-facing slopes. The closest designated LSRs are located approximately one-half (0.5) mile to the southeast where mature forest can be found at higher elevations (Snohomish County Public Works 2015b, p. 22).

Observations made in the field on January 12, 2016, confirm that the second growth stands located within the project area do not provide suitable marbled murrelet nesting habitat. These stands do exhibit high canopy closure (>70 percent) at some locations. However, a multi-storied canopy providing good vertical and horizontal cover is generally absent. Although few, if any, trees with lateral limbs providing a 4 inch-diameter (minimum) platform (located 33 or more ft off the forest floor) were observed throughout the limits of construction (estimated at 11.5 to 12.2 acres), the field survey was not comprehensive and did not include all trees within 0.25 mile of the project corridor.

Summary

The Service expects that the proposed action's measurable effects to the marbled murrelet will be temporary and construction-related. Construction will result in temporary increases in sound and visual disturbance for the duration of two or three construction seasons (April through October). If marbled murrelets nest in the action area, they may experience temporary elevated levels of disturbance. However, this disturbance will be limited in both physical extent and duration, and the Service expects that most temporary exposures will not cause or contribute to marbled murrelet nest abandonment or failure.

There are no current data to describe marbled murrelet occupancy in the action area, and no ornithological radar survey data for these portions of the MBSNF. A coarse-scaled spatial analysis suggests that the action area, extending to a distance of approximately 1.5 miles, is approximately 6,665 acres in size and contains approximately 934 acres of suitable to highly suitable marbled murrelet nesting habitat. This same analysis suggests that of the approximately 488 acres (total) located within 0.25 mile of the project corridor, only 18 acres represent suitable to highly suitable marbled murrelet nesting habitat.

The proposed action will have foreseeable adverse effects to the marbled murrelet. Suitable, un-surveyed, and therefore potentially occupied marbled murrelet nesting habitat is present within 0.25 mile of proposed blasting operations and will be exposed to sound levels in excess of 92 dBA during the nesting season (April 1 to September 23). With consideration for the timing and duration of construction activities, and the quality of available nesting habitat in close proximity to the construction corridor, the Service has concluded that adverse exposures and effects to nesting marbled murrelets are reasonably certain to occur.

The Service expects that adverse effects to marbled murrelets will be difficult to detect. Marbled murrelets are cryptic and nest locations are rarely located. The Service has quantified how much suitable to highly suitable marbled murrelet nesting habitat would be exposed to proposed blasting operations (18 acres). These habitat areas serve as a reasonable surrogate measure indicating where adverse exposures and effects to nesting marbled murrelets are foreseeable and reasonably certain to occur.

Marbled murrelets that attempt to nest within 0.25 mile of proposed blasting operations are likely to experience sound and visual disturbance sufficient to cause a flushing response and/or temporary inattention to the nest. The Service expects that these exposures to construction activities will, under a reasonable worst-case scenario, interrupt the brooding of eggs or chicks, and/or the regular feeding of chicks, at one or more locations. These temporary exposures will significantly disrupt marbled murrelet nesting behaviors and create a likelihood of injury. However, since elevated sound levels resulting from blasting operations will be short in duration, the Service expects that most temporary exposures will not cause or contribute to nest abandonment or failure.

The following sub-sections discuss the effects of the action in greater detail: insignificant and discountable effects, including effects to suitable marbled murrelet habitat; and the foreseeable adverse effects of the action.

Insignificant and Discountable Effects

Some of the proposed action's potential effects to the marbled murrelet are insignificant or discountable. Effects to marbled murrelets resulting from the following items of work are considered extremely unlikely to occur (discountable), or will not be measurable or detectable (insignificant):

- All work and staging conducted within the project area and limits of construction, excluding blasting operations.

- Routine hauling and transport of equipment and materials to and from the project area and along the project corridor.

- Staging when conducted at locations within the project area and limits of construction.

Sound levels associated with typical construction activities using conventional heavy equipment will attenuate to ambient sound levels at a distance of approximately 2,000 ft. Sound levels sufficient to disrupt marbled murrelet nesting behaviors will not extend to suitable or potentially suitable nesting habitats as a result of construction activities with conventional heavy equipment (i.e., excluding blasting operations).

Construction will be staged from the existing roadway alignment. Other suitable, previously disturbed areas will be used to the fullest extent practicable. The WSDOT and County have not identified any detour routes that may be needed during construction. Therefore, we assume for the purposes of assessing potential effects, that there will be no temporary detours greater than a few hundred feet off the project corridor.

Similarly, for the reasons described below, the following direct and indirect effects are considered extremely unlikely to occur (discountable), or will not be measurable or detectable (insignificant):

- Physical removal and/or functional alteration of stands providing suitable marbled murrelet habitat.
- Direct physical disturbance or destruction of active marbled murrelet nests or eggs.
- Crowding or displacement of breeding pairs.
- Increased risk of predation.

The proposed action will not physically remove or functionally alter stands providing suitable marbled murrelet nesting habitat. Based on observations made in the field, including observations of stand conditions throughout the proposed limits of construction, there appear to be no suitable or potentially suitable nest trees in the project area (i.e., no trees or stands exhibiting high canopy closure, with a multi-storied canopy providing good vertical and horizontal cover, and lateral limbs providing a 4 inch-diameter nest platforms located 33 or more ft off the forest floor). It is extremely unlikely that an active marbled murrelet nest might be encountered or damaged. The direct physical disturbance or destruction of any occupied nest or eggs is extremely unlikely, and therefore considered discountable.

The proposed action will not result in changes in the use or function of the road infrastructure, and will not construct new points of access or increase traffic or visitor capacity. No future development proposals or other major actions are contingent or dependent upon the proposed action. The Service expects that no discernible changes in the rate or pattern of land use conversion will result, in whole or in part, from the action. We also expect that no discernible changes in long-term public use or management will result from the proposed action. Indirect effects to marbled murrelets (e.g., crowding or displacement of breeding pairs; increased risk of predation) are extremely unlikely, and therefore considered discountable.

Adverse Effects of the Action

The following sub-sections further discuss the foreseeable adverse effects of the action. These sub-sections rely on and apply basic science and policy developed by the Service’s Washington Fish and Wildlife Office for the purpose of informing section 7 consultations within the marbled murrelet’s range in Washington State: Marbled Murrelet Nesting Season and Analytical Framework for Section 7 Consultation in Washington (WFWO 2012a.); Guidance for Identifying Marbled Murrelet Nest Trees in Washington State (WFWO 2012b); and, Revised In-Air Disturbance Analysis for Marbled Murrelets (Teachout 2015).

Marbled Murrelet Nesting Season and Nesting Requirements in Washington State

The following key points are most pertinent to this analysis (WFWO 2012a):

- The nesting season in Washington State is best defined as the period from April 1 to September 23. Due to the large temporal overlap during the nesting season when marbled murrelets have eggs or chicks on their nests, we no longer distinguish between an "early" and "late" nesting season or period. Calendar dates for nest establishment, egg laying, brooding, hatching, and fledging are too variable, with too much overlap, to reliably distinguish an "early" and "late" nesting season.

- Due to the high proportion of feedings during the morning and evening hours, limited operating periods (LOPs) remain an appropriate measure to reduce exposure of nesting marbled murrelets to disturbance. We continue to recommend or require LOPs from two hours after sunrise to two hours before sunset. However, because mid-day feedings do occur, we cannot assume that implementation of LOPs will fully avoid all potential adverse effects to marbled murrelets, eggs, or chicks.

The following key points from that appendix are most pertinent to this analysis (WFWO 2012b):

- The most important component is the presence of platforms. Old-growth, mature, or younger aged coniferous forests with appropriate structure can provide these platforms. Platforms may be clumped in one area, or dispersed throughout the forested area or stand.

- Higher quality nest sites have platforms that are generally protected by branches above (vertical cover) and/or to the side (horizontal cover). Limbs and foliage within the same tree, or in adjacent trees, can provide this cover.

- Although tree diameter and height have been positively correlated with platform size and abundance, this relationship may depend on tree species and forest type. If adequate structure is present, tree diameter and height should not be used to limit consideration of nest tree/stand suitability. Tree diameter (dbh) should not be averaged at the stand level.

Marbled Murrelet Response to Ground-Based Activities

The following key points are most pertinent to this analysis (Teachout 2015):

- A disturbance event is considered significant if it causes a marbled murrelet to delay or avoid nest establishment, flush away from an active nest site, or abort a feeding attempt during incubation or brooding. These events are considered significant because they have the potential to result in reduced hatching success, fitness, or survival of juveniles and adults.

- Disturbance that causes an adult to abort prey delivery creates a likelihood of injury for the adult through an increased energetic cost, and by exposing the adult to an increased risk of predation. Protracted disturbance may impose an energetic cost associated with increased adult vigilance around the nest.

- Chicks appear to be more tolerant of disturbance than adults. However, disturbance that shortens or interferes with feeding/prey exchanges may be detrimental. Missed mid-day feedings probably present the greatest risk to exposed chicks. Observational data suggest that chicks are unlikely to flush in response to disturbance resulting from ground-based activities.

- Ground-based activities are a continuous source of sound and visual disturbance in the forest environment. These activities include maintenance and construction employing heavy equipment. However, observational data suggest that adult marbled murrelets sometimes react negatively to the mere presence of humans in close proximity, or when people approach the nest tree.

- Responses to ground-based activities are influenced by a combination of both sound (or auditory) and visual stimuli. Predicting responses merely as a function of distance from the sound source is difficult, and may not be reliable or appropriate.

- Observational data have led researchers to recommend disturbance buffers of at least 100 meters. Best available science suggests that ground-based activities conducted within 100 meters of an active marbled murrelet nest present sound and visual disturbance sufficient to significantly disrupt normal behaviors (i.e., nest establishment, incubation, brooding, and feeding).

- Impulsive sound (e.g., sound resulting from impact pile driving or blasting) may be more disruptive than continuous sounds due to the associated noise levels and/or the concussive nature of the sounds.

- There is only limited information regarding sound levels associated with various types of blasting. The sounds produced by blasting are highly variable and dependent on the size and type of charge, the material being blasted, and whether noise minimization techniques are employed.

- For blasting events, we consider the potential disruption zone (flush response) for marbled murrelets to be a 0.25-mile radius around the project site. This is based on the findings of Holthuijzen et al. (1990, p. 273), with an increase over the recommended distance to include potential flush responses.

Marbled Murrelet Exposure and Response to Proposed Construction Activities

Marbled murrelets that attempt to nest within 0.25 mile of proposed blasting operations are likely to experience sound and visual disturbance sufficient to cause a flushing response and/or temporary inattention to the nest. The Service expects that these exposures to construction activities will, under a reasonable worst-case scenario, interrupt the brooding of eggs or chicks, and/or the regular feeding of chicks, at one or more locations.

With consideration for timing and duration, and the quality of available nesting habitat in close proximity to the construction corridor, the Service has concluded that adverse exposures and effects to nesting marbled murrelets are reasonably certain to occur. These temporary exposures will significantly disrupt marbled murrelet nesting behaviors and create a likelihood of injury. However, with full and successful implementation of the agreed-upon conservation measures, the Service expects that most temporary exposures will not cause or contribute to nest abandonment or failure.

Exposure

The Service has quantified how much suitable to highly suitable marbled murrelet nesting habitat would be exposed to proposed blasting operations (18 acres). These habitat areas serve as a reasonable surrogate measure indicating where adverse exposures and effects to nesting marbled murrelets are foreseeable and reasonably certain to occur. Exactly how many individuals will or may be exposed to disturbance resulting from proposed blasting operation is unknown. As a surrogate measure of these adverse exposures and effects, a total of approximately 18 acres of marbled murrelet nesting habitat will be exposed to construction activities over the course of two or three, full or partial, construction seasons.

Response

Temporary, construction-related exposures will significantly disrupt marbled murrelet nesting behaviors and create a likelihood of injury. However, with full and successful implementation of the agreed-upon conservation measures, the Service expects that most temporary exposures will not cause or contribute to nest abandonment or failure.

Sound and visual disturbance that causes an adult marbled murrelet to abort or delay prey delivery creates a likelihood of injury for the adult through an increased energetics cost, and by exposing the adult to an increased risk of predation. Hull et al. (2001, p. 1036) report that marbled murrelets spend 0.3 to 3.5 h per day (mean 1.2 ± 0.7 h per day) commuting to nests during the breeding season. The distance traveled between the nest site and foraging areas ranged from 12 to 102 km, and requires substantial energy demands. Each flight to the nest is energetically costly, increases the risk of predation from avian predators, and detracts from time spent in other activities such as foraging (Hull et al. 2001, p. 1036). Increases to prey capture and delivery effort results in reduced adult body condition by the end of the breeding season, and increases the predation risks to adults and chicks as more trips inland are required (Kuletz 2005, pp. 43-45).

Chicks are fed primarily during dawn and dusk periods, but may also be fed throughout the day (Nelson 1997, p.18). Nelson and Hamer (1995, p. 62) report that relatively few feedings take place during the daytime. However, in some areas, 31 to 46 percent of feedings take place during the mid-day hours.

Missed feedings can reduce the growth and/or fitness of marbled murrelet chicks. Adults feed chicks 1 to 8 times per day (mean = 3.2 ±1.3 SD) (Nelson and Hamer 1995b, p. 61). If we assume an average of 4 feedings per day, a single aborted feeding would constitute a loss of 25 percent of the daily food intake.

Bloxton and Raphael (2009) indicate that within its' Washington range, marbled murrelets are not initiating nesting, or are abandoning their nests during incubation or rearing, most likely in response to poor foraging conditions. For those that do initiate nesting, brooding, and rearing, the implications of missed feedings are significant. Missed feeding may cause a delay in the development of the chick, prolonging the time to fledging, and increasing the risk of predation or abandonment by the adults. If disturbance at a nest site is prolonged, each successive day or night of construction and resulting disturbance creates an increasing risk that multiple missed feedings will cause a significant delay in the chick's growth and development, cause permanent stunting, or result in mortality due to severe malnourishment.

However, with full and successful implementation of the agreed-upon conservation measures, the Service expects that chicks occupying nests within 0.25 mile of proposed blasting operations will receive a minimum of one or more feedings during dawn and dusk hours. We assume that the majority of daily feedings occur during dawn/dusk hours and that these feedings will generally be sufficient to sustain the development of the chick. However, and especially at sites where prolonged disturbance may result in multiple missed feedings over days or weeks, some chicks may suffer from reduced growth and low fledging weight. This will depend, in part, on the quality of the diet the chick is provided, and the proportion of mid-day feedings that are missed.

Kuletz (2005, p. 85) developed a model to examine the relationship between the energy requirements of marbled murrelet chicks and the number of daily feedings required for fledging. Depending on the energy content of the prey items delivered, minimum daily feedings range from approximately two herring to eight sand lance per day (Kuletz 2005, p. 85). Over the course of the 27- to 40-day period during which the chick matures, the estimated total number of feedings required for successful fledging ranges from 38 (age 1+ herring) to 204 (sand lance) (Kuletz 2005, p. 85). Because marbled murrelets are somewhat adapted to inconsistent provisioning, and because the agreed-upon conservation measures will allow for some feedings to occur each day, we expect that most nests exposed to sound resulting from proposed blasting operations will still fledge chicks, although fledgling weights may be low, or the development time to fledging may be increased.

Although we recognize that prolonged disturbance at a site, resulting in multiple missed feedings over days or weeks, has the potential to result in severe malnourishment (injury) and/or mortality, we are not reasonably certain that these outcomes will occur. Because of inherent variability and uncertainty, the Service is not currently able to predict with reasonable certainty the number of missed feedings that would result in injury or death of marbled murrelet chicks.

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action (USFWS and NMFS 1998).

The proposed action will not result in changes in the use or function of the road infrastructure, and will not construct new points of access or increase traffic or visitor capacity. No future development proposals or other major actions are contingent or dependent upon the proposed action. The Service expects that no discernible changes in the rate or pattern of land use conversion will result, in whole or in part, from the action. We also expect that no discernible changes in long-term public use or management will result from the proposed action. Indirect effects to marbled murrelets (e.g., crowding or displacement of breeding pairs; increased risk of predation) are extremely unlikely, and therefore considered discountable.

With full and successful implementation of the agreed-upon conservation measures, the Service concludes that the proposed action's indirect effects will have an insignificant effect on the marbled murrelet, their habitat, and prey resources. The action will have no foreseeable adverse effects occurring later in time.

Effects of Interrelated and Interdependent Actions

Interrelated actions are defined as actions "that are part of a larger action and depend on the larger action for their justification;" interdependent actions are defined as actions "that have no independent utility apart from the action under consideration" (50 CFR section 402.02).

Construction will be staged from the existing roadway alignment. Other suitable, previously disturbed areas will be used to the fullest extent practicable. The WSDOT and County have not identified any detour routes that may be needed during construction. Therefore, we assume for the purposes of assessing potential effects, that there will be no temporary detours greater than a few hundred feet off the project corridor.

There are no other identifiable interrelated or interdependent actions. No measurable effects to marbled murrelet individuals or habitat are expected to result from interrelated or interdependent actions.

CUMULATIVE EFFECTS: **Bull Trout and Designated Bull Trout Critical Habitat**

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The Service is not aware of any specific future actions that are reasonably certain to occur in the action area, and none in the upper North Fork Skykomish River sub-basin that are likely to contribute to cumulative effects on bull trout or designated bull trout critical habitat. Many, if not all, of the foreseeable future actions that would or might have significance for bull trout and designated bull trout critical habitat are likely to have an independent federal nexus, and would therefore be subject to the requirements of a separate section 7 consultation process. We expect that the cumulative effects of future State, Tribal, local, and private actions are likely to maintain the current conditions in the action area in the future.

CUMULATIVE EFFECTS: **Marbled Murrelet**

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The Service is not aware of any specific future actions that are reasonably certain to occur in the action area, and none in the upper North Fork Skykomish River sub-basin that are likely to contribute to cumulative effects on marbled murrelets or their habitat. Many, if not all, of the foreseeable future actions that would or might have significance for marbled murrelets or their habitat are likely to have an independent federal nexus, and would therefore be subject to the requirements of a separate section 7 consultation process. We expect that the cumulative effects of future State, Tribal, local, and private actions are likely to maintain the current conditions in the action area in the future.

INTEGRATION and SYNTHESIS: **Bull Trout and Designated Bull Trout Critical Habitat**

The Integration and Synthesis section is the final step in assessing the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action and the cumulative effects to the status of the species and critical habitat, and the environmental baseline, to formulate our biological opinion as to whether the proposed action is likely to: 1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or 2) reduce the value of designated critical habitat for the conservation of the species.

Bull Trout

The action area contains rearing and FMO habitat for migratory (fluvial and anadromous) bull trout of the Snohomish-Skykomish River core area, and lies in close proximity to productive bull trout spawning habitats. The action area is presumed to support adult, subadult, and juvenile bull trout originating from three of the core areas four known local populations (the North Fork Skykomish River, including Goblin and West Cady Creeks; Salmon Creek; and, the South Fork Skykomish River). Current information suggests that each of these local populations has experienced significant variation in numbers (abundance) since the time of listing (1998).

The proposed action incorporates both permanent design elements and conservation measures which will reduce effects to habitat and avoid and minimize impacts during construction. The action's temporary adverse effects are limited in both physical extent and duration. The incorporated permanent design elements will partially offset the action's permanent adverse effects, create and maintain functioning habitat, and avoid the damage resulting from repeat emergency repairs within the project area.

With full implementation of the proposed conservation measures, we expect low numbers of adult, subadult, and juvenile bull trout will be adversely affected by construction activities. Exposure to construction activities may injure or kill a limited number of bull trout, estimated at two individuals in total. Construction activities will also significantly disrupt normal bull trout behaviors (feeding, moving, and sheltering). Construction activities may temporarily delay or discourage adult migration through the action area, but will have no effect on bull trout spawning habitat or essential spawning behaviors.

The proposed action will reduce, but not permanently eliminate, a long-standing constraint on the North Fork Skykomish River's CMZ. Buried rock revetments constructed at the periphery of the CMZ will remain as a permanent feature. Indirect effects will include a reduced incidence of overbank flows and interrupted patterns of erosion, sedimentation, and recruitment of large wood. Were it not for the inclusion of permanent design elements that partially offset these adverse effects, we would expect simplified and homogenized instream structure to result in time along the affected bank.

The proposed action will incorporate a significant amount of large wood, creating bank roughness and complex habitat at the periphery of the CMZ. The action will restore floodplain connectivity to more than 200,000 ft^2 (4.6 acres) of floodplain, reduce impediments to flood flow conveyance, and improve the storage and attenuation of flood flows. The proposed action will increase channel and floodplain roughness, and thereby lessen hydraulic forces and resulting bed and bank erosion. The Service expects that the proposed action will maintain a diverse and complex assemblage of instream habitats along the affected reach, including a range of channel depths, complex cover, and resting and refuge habitat from stream velocities and forces.

While the proposed action may injure or kill a limited number of bull trout and will significantly disrupt normal bull trout behaviors (feeding, moving, and sheltering), we expect that any temporary effects to bull trout abundance (numbers) or productivity (reproduction) will not be measurable at the scale of the local populations or core area. The foreseeable direct and indirect effects of the proposed action (permanent and temporary) will not preclude bull trout from rearing, foraging, migrating, and overwintering within the action area.

The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will not measurably reduce bull trout productivity (reproduction), abundance (numbers), or distribution at the scale of the core area or Coastal Recovery Unit. The anticipated direct and indirect effects of the proposed action will not alter the status of the bull trout at the scale of the Coastal Recovery Unit or coterminous range.

Designated Bull Trout Critical Habitat

The action area extends along approximately 1 linear mile of the North Fork Skykomish River, including its left-bank side channel, the CMZ, and associated portions of the 100-year floodplain. All or nearly all of these habitats are designated as critical habitat for the bull trout. Eight of the nine PCEs of designated bull trout critical habitat are present in the action area.

The action area contains rearing and FMO habitat for migratory (fluvial and anadromous) bull trout of the Snohomish-Skykomish River core area, and lies in close proximity to productive bull trout spawning habitats. The action area is presumed to support adult, subadult, and juvenile bull trout originating from three of the core areas four known local populations (the North Fork Skykomish River, including Goblin and West Cady Creeks; Salmon Creek; and, the South Fork Skykomish River).

The North Fork Skykomish River local population is the largest, most abundant, and most productive population in the entire Snohomish-Skykomish River core area. Long-term viability of the North Fork Skykomish River local population is critically important to maintaining the overall distribution of migratory life history forms throughout core area. The action area serves as an essential migratory corridor providing connectivity between three of the Snohomish-Skykomish River core area’s four local populations.

The proposed action will have both direct and indirect effects to bull trout critical habitat. Some of these effects will be temporary, construction-related and limited in both physical extent and duration. Others will be permanent or long-term, lasting for the functional life of the constructed features. The proposed action incorporates permanent design elements and conservation measures which will partially offset effects to critical habitat, and avoid and minimize impacts during construction. None of the proposed action’s temporary adverse effects to the PCEs of bull trout critical habitat are expected to persist for more than two years after construction.

The proposed action will have significant, unavoidable temporary impacts to riparian buffers associated with 11.5 to 12.2 acres of clearing and grading. However, the proposed action will also: 1) restore and re-establish at least 1 acre of riparian buffer throughout the abandoned alignment, 2) restore and enhance riparian function with native plantings across more than 8 acres of the temporary footprint (including stabilized side slopes), and 3) mitigate off-site with the purchase of credits at an established mitigation bank for the permanent impacts and loss of approximately 3.3 acres of riparian buffer. Furthermore, by relocating most of the roadway section away from the North Fork Skykomish River and CMZ, by restoring connectivity to more than 4.6 acres of floodplain, and by installing large wood along the buried rock revetments and in the restored riparian buffers, the proposed action will avoid permanent adverse effects to riparian functions.

The proposed action will reduce, but not permanently eliminate, a long-standing constraint on the North Fork Skykomish River's CMZ. Buried rock revetments constructed at the periphery of the CMZ will remain as a permanent feature. Indirect effects will include a reduced incidence of overbank flows and interrupted patterns of erosion, sedimentation, and recruitment of large wood. Were it not for the inclusion of permanent design elements that partially offset these adverse effects, we would expect simplified and homogenized instream structure to result in time along the affected bank.

The proposed action will incorporate a significant amount of large wood, creating bank roughness and complex habitat at the periphery of the CMZ. The action will restore floodplain connectivity to more than 200,000 ft^2 (4.6 acres) of floodplain, reduce impediments to flood flow conveyance, and improve the storage and attenuation of flood flows. The proposed action will increase channel and floodplain roughness, and thereby lessen hydraulic forces and resulting bed and bank erosion.

The Service expects that the proposed action will maintain a diverse and complex assemblage of instream habitats along the affected reach, including a range of channel depths, complex cover, and resting and refuge habitat from stream velocities and forces. The Service expects beneficial long-term effects to floodplain and riparian processes, including large wood recruitment. The proposed action will enhance and not degrade floodplain and riparian functions and processes. The foreseeable direct and indirect effects of the proposed action (permanent and temporary) will not preclude bull trout from rearing, foraging, migrating, and overwintering within the action area.

Within the action area, designated bull trout critical habitat will retain its current ability to establish functioning PCEs. The anticipated direct and indirect effects of the action, combined with the effects of interrelated and interdependent actions, and the cumulative effects associated with future State, tribal, local, and private actions will not prevent the PCEs of designated bull trout critical habitat from being maintained, and will not degrade the current ability to establish functioning PCEs at the scale of the action area. Critical habitat within the action area will continue to serve the intended conservation role for the species at the scale of the core area, Coastal Recovery Unit, and coterminous range.

INTEGRATION and SYNTHESIS: Marbled Murrelet

The Integration and Synthesis section is the final step in assessing the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action and the cumulative effects to the status of the species and critical habitat, and the environmental baseline, to formulate our biological opinion as to whether the proposed action is likely to: 1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or 2) reduce the value of designated critical habitat for the conservation of the species.

The Service has concluded that the proposed action will interrupt the brooding of marbled murrelet eggs or chicks, and/or the regular feeding of chicks, at one or more locations. These temporary exposures will significantly disrupt marbled murrelet nesting behaviors and create a likelihood of injury. The Service has also concluded that, despite the long period of construction (i.e., two or three, full or partial, construction seasons), relatively few instances of nest abandonment or failure are likely to occur (i.e., the nest abandonment or failure rate should be low).

Available data suggest a patchy and inconsistent distribution of marbled murrelets in the action area, and it appears that the action area may support relatively few marbled murrelets. The action area, to a distance of 1.5 miles, includes approximately 934 acres of suitable to highly suitable marbled murrelet nesting habitat. However, these suitable habitats are fragmented and discontinuous. With consideration for these data and the surrounding landscape context, the Service concludes it is unlikely that suitable habitats located within 0.25 mile of proposed blasting operations support a significant concentration of nesting marbled murrelets.

The proposed action will not physically remove or functionally alter stands providing suitable marbled murrelet nesting habitat. Based on observations made in the field, including observations of stand conditions throughout the proposed limits of construction, there appear to be no suitable or potentially suitable nest trees in the project area. The Service expects that no discernible changes in public use or management will result from the action. No measurable indirect effects to marbled murrelets (e.g., crowding or displacement of breeding pairs; increased risk of predation) are expected to result from the proposed action.

The Service expects that the direct and indirect effects of the proposed action, considered together with the effects of any interrelated or interdependent actions, and the cumulative effects of future State, tribal, local, and private actions, will not cause a measurable decline in juvenile recruitment or productivity at the scale of the stand, action area, or larger landscape. The Service expects that the action will have no effect on marbled murrelet distribution at the scale of the stand, action area, or larger landscape. The action will not cause a recognizable decline in marbled murrelet abundance (numbers) or productivity (reproduction), and will not affect distribution of the species, in Conservation Zone 1 or across the species' listed range.

CONCLUSION: **Bull Trout and Designated Bull Trout Critical Habitat**

The Service has reviewed the current rangewide status of the bull trout, the environmental baseline for the action area, the direct and indirect effects of the proposed action, the effects of interrelated and interdependent actions, and the cumulative effects that are reasonably certain to occur in the action area. It is the Service's Biological Opinion that the action, as proposed, will not appreciably reduce the likelihood of survival and recovery of the bull trout in the wild. The action, as proposed, is not likely to jeopardize the continued existence of the bull trout.

The Service has reviewed the current rangewide status of designated bull trout critical habitat, the environmental baseline for the action area, the direct and indirect effects of the proposed action, the effects of interrelated and interdependent actions, and the cumulative effects that are reasonably certain to occur in the action area. It is the Service's Biological Opinion that the action, as proposed, will not degrade the current ability to establish functioning PCEs at the scale of the action area. Within the action area, critical habitat will continue to serve the intended conservation role for the bull trout.

CONCLUSION: **Marbled Murrelet**

The Service has reviewed the current rangewide status of the marbled murrelet, the environmental baseline for the action area, the direct and indirect effects of the proposed action, the effects of interrelated and interdependent actions, and the cumulative effects that are reasonably certain to occur in the action area. It is the Service's Biological Opinion that the action, as proposed, will not appreciably reduce the likelihood of survival and recovery of the marbled murrelet in the wild. The action, as proposed, is not likely to jeopardize the continued existence of the marbled murrelet.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. *Harm* is defined by the Service as an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering (50 CFR 17.3). *Harass* is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the FHWA so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The FHWA has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the FHWA 1) fails to assume and implement the terms and conditions or 2) fails to require the contractor or applicant to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the FHWA must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement [50 CFR section 402.14(i)(3)].

AMOUNT OR EXTENT OF TAKE

The Service expects that incidental take of **bull trout**, in the forms of both harm and harassment, will result from the proposed action.

1. Incidental take of bull trout in the form of *harm* (physical injury or mortality) resulting from handling related to fish capture and removal operations.

    - One adult or subadult bull trout and one juvenile bull trout will be harmed as a result of fish capture and removal operations conducted between August 1 and August 31 (60 working days; two in-water construction seasons).

2. Incidental take of bull trout in the form of *harassment* (stress not reaching the level of physical injury) resulting from handling related to fish capture and removal operations.

    - Two adult or subadult bull trout and three juvenile bull trout will be harassed as a result of fish capture and removal operations conducted between August 1 and August 31 (60 working days; two in-water construction seasons).

The Service expects that incidental take of individuals will be difficult to detect or quantify for the following reasons: 1) the low likelihood of finding dead or injured individuals; 2) delayed mortality; and, 3) losses may be masked by seasonal fluctuations in numbers. Where this is the case, we use a description of the affected habitat, based on the physical extent of effects, as a surrogate indicator of take.

3. Incidental take of bull trout in the form of *harassment* resulting from degraded surface water quality and exposure to elevated turbidity and sedimentation during construction. Water quality will be degraded intermittently during the approximately 60-day period when construction activities are being completed below the OHWM of the North Fork Skykomish River. Take will result when levels of turbidity reach or exceed the following:

    i) 50 NTUs above background at any time; or

    ii) 20 NTUs above background for more than 1 hour, continuously; or

    iii) 10 NTUs above background for more than 3 hours, cumulatively, over a 10-hour workday; or

iv) 5 NTUs above background for more than 7 hours, cumulatively, over a 10-hour workday.

- All adult, subadult, and juvenile bull trout within the wetted perimeter of the North Fork Skykomish River, from a point approximately 100 ft upstream to a point approximately 300 ft downstream of construction activities, will be harassed between August 1 and August 31 (60 working days; two in-water construction seasons).

4. Incidental take of bull trout in the form of *harassment* resulting from temporary increased sedimentation along the downstream reach.

   - All adult, subadult, and juvenile bull trout within the wetted perimeter of the North Fork Skykomish River, extending to a distance of 0.25 mile downstream, and for a duration of up to two years after construction.

5. Incidental take of bull trout in the form of *harassment* resulting from bank hardening and associated permanent adverse effects to instream and off-channel habitats.

   - All bull trout associated with approximately 1,700 linear ft of the North Fork Skykomish River, indefinitely and for the functional life of the constructed features.

The Service expects that incidental take of **marbled murrelets**, in the form of harassment, will result from the proposed action.

The Service expects that incidental take of individuals will be difficult to detect or quantify for the following reasons: 1) the low likelihood of finding dead or injured individuals; 2) delayed mortality; and, 3) losses may be masked by seasonal fluctuations in numbers. Where this is the case, we use a description of the affected habitat, based on the physical extent of effects, as a surrogate indicator of take.

6. *Harassment* of all marbled murrelets nesting within 0.25 mile of proposed blasting operations, resulting from exposure to construction-related sources of disturbance and a significant disruption to nesting behaviors.

   - All marbled murrelet adults and chicks nesting within approximately 18 acres of habitat will be harassed, creating a likelihood of injury, over the course of two or three construction and nesting seasons.

EFFECT OF THE TAKE

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy of the bull trout or marbled murrelet.

REASONABLE AND PRUDENT MEASURES

The Service believes that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize, monitor, and report the impacts (i.e., the amount or extent) of incidental take on the **bull trout**:

1. (RPM 1) Minimize and monitor incidental take caused by handling related to fish capture and removal operations.

2. (RPM 2) Minimize and monitor incidental take caused by elevated turbidity and sedimentation during construction.

The proposed action incorporates conservation measures which we expect will avoid effects to marbled murrelet habitat and reduce temporary exposures and effects during construction. We expect that the FHWA will fully implement these conservation measures and therefore they have not been specifically identified as RPMs or terms and conditions.

The Service believes that the following RPM is necessary and appropriate to minimize, monitor, and report the impacts (i.e., the amount or extent) of incidental take on the **marbled murrelet**:

3. (RPM 3) Monitor and report construction activities, including implementation of the seasonal work timing restrictions, removal of mature forest, and the frequency and duration of blasting operations.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the FHWA must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The following terms and conditions are required for the implementation of RPM 1:

1. The FHWA, WSDOT, and County shall ensure that fish capture and removal operations are conducted by a qualified biologist, and that all staff participating in the operation have the necessary knowledge, skills, and abilities to ensure safe handling of fish. Fish capture and removal operations shall take all appropriate steps to minimize the amount and duration of handling. The operations shall maintain captured fish in water to the maximum extent possible during seining/netting, handling, and transfer for release, to prevent and minimize stress.

2. The FHWA, WSDOT, and County shall ensure that water quality conditions are adequate in the buckets or tanks used to hold and transport captured fish. The operations shall use aerators to provide for the circulation of clean, cold, well-oxygenated water, and/or shall stage fish capture, temporary holding, and release, to minimize the risks associated with prolonged holding.

3. The FHWA, WSDOT, and County shall only employ electrofishing if all other means of fish capture and removal have been determined impracticable, and only after a qualified biologist determines that adult and subadult fish have been effectively removed. Electrofishing methods shall use the minimum voltage, pulse width, and rate settings necessary to immobilize fish. Water conductivity shall be measured in the field before electrofishing to determine appropriate settings. Electrofishing equipment and methods shall comply with the electrofishing guidelines outlined by the NMFS (NMFS 1997).

4. The FHWA, WSDOT, and County shall provide notice to the Service's consulting biologist (Ryan McReynolds, 360-753-6047) a minimum of ten days prior to fish capture and removal operations. Upon request, the FHWA and WSDOT shall permit the Service or its designated representative to observe fish capture and removal operations.

5. The FHWA, WSDOT, and County shall document and report all bull trout or other salmonids encountered during fish capture and removal operations. The FHWA and WSDOT shall submit a monitoring report to the Service's consulting biologist (Ryan McReynolds, 360- 753-6047) at the Washington Fish and Wildlife Office in Lacey, Washington, by December 15 following each in-water construction season.

The following terms and conditions are required for the implementation of RPM 2:

1. The FHWA, WSDOT, and County shall monitor turbidity levels in the North Fork Skykomish River during sediment-generating activities. Monitoring shall be conducted at a distance of 300 ft from sediment-generating activities.

2. Monitoring shall be conducted at 30-minute intervals from the start of sediment-generating activities. If turbidities measured over the course of three consecutive 30-minute sample intervals do not exceed 5 NTUs over background, then monitoring of sediment-generating activities will be conducted for the remainder of the workday at a frequency of once every 6 hours, or if there is a visually appreciable increase in turbidity.

3. If, at any time, monitoring conducted 300 ft from sediment-generating activities indicates turbidity in excess of 5 NTUs over background, monitoring shall be conducted at 30-minute intervals until turbidity falls below 5 NTUs over background.

4. If turbidity levels measured at 300 ft from the sediment-generating activities exceed 50 NTUs above background at any time, 20 NTUs above background for more than 1 hour continuously, 10 NTUs above background for up to 7 hours, cumulatively, over a 12-hour workday, or 5 NTUs above background for more than 7 hours, cumulatively, over a 12-hour workday, then the amount of take authorized by the Incidental Take Statement will have been exceeded. Sediment-generating activities shall cease, and the FHWA shall contact the Federal Activities Branch at the Washington Fish and Wildlife Office in Lacey, Washington (360-753-9440) within 24 hours.

5. Monitoring shall be conducted to establish background turbidity levels away from the influence of sediment-generating activities. Background turbidity shall be monitored at least twice daily during sediment-generating activities. In the event of a visually appreciable change in background turbidity, an additional sample shall be taken.

6. If, in cooperation with other permit authorities, the FHWA or WSDOT develop a functionally equivalent monitoring strategy, they may submit this plan to the Service for review and approval in lieu of the above monitoring requirements. The strategy must be submitted to the Service a minimum of 60 days prior to construction. In order to be approved for use in lieu of the above requirements, the plan must meet each of the same objectives.

7. The FHWA, WSDOT, and County shall submit a monitoring report to the Washington Fish and Wildlife Office in Lacey, Washington (Attn: Ryan McReynolds, Federal Activities Branch), by December 15 following each construction season. The report shall include, at a minimum, the following: (a) dates, times, and locations of construction activities, (b) monitoring results, sample times, locations, and measured turbidities (in NTUs), (c) summary of construction activities and measured turbidities associated with those activities, and (d) summary of corrective actions taken to reduce turbidity.

The following terms and conditions are required for the implementation of RPM 3.

1. When developing final plans for construction, the FHWA, WSDOT, and County shall include enforceable contract specifications to ensure full and successful implementation of the agreed-upon conservation measures.

2. The FHWA, WSDOT, and County shall prepare a schedule in advance of each year’s construction activities. The schedule shall outline and communicate seasonal and day/night work timing restrictions, with reference to specific work and staging locations. The FHWA and WSDOT shall provide the schedule to the selected Contractor(s) and work cooperatively to refine and adaptively manage implementation of the schedule, including contingencies.

3. The FHWA, WSDOT, and County shall conduct a field review of work and staging locations in advance of each year's construction activities. The FHWA and WSDOT shall assess the limits of construction, and identify and confirm that work and staging will not result in impacts to mature stands or trees providing suitable habitat for the marbled murrelet; i.e., trees or stands exhibiting high canopy closure, with a multi-storied canopy providing good vertical and horizontal cover, and lateral limbs providing a 4 inch-diameter (minimum) nest platform (located 33 or more ft off the forest floor).

4. If a field review of the limits of construction identifies trees providing suitable marbled murrelet nest platforms, the FHWA, WSDOT, and County shall notify the Service at their earliest convenience. The FHWA, WSDOT, and County shall coordinate with the Service to positively confirm the absence of nesting marbled murrelets and/or postpone clearing until after the marbled murrelet nesting season.

5. The FHWA, WSDOT, and County shall monitor and report the frequency and duration of blasting operations.

6. The FHWA, WSDOT, and County shall prepare, and provide to the Service no later than December 15, a summary of each year's construction activities. The summary shall describe implementation of the seasonal and day/night work timing restrictions, and any schedule/construction contingencies and adaptive management. The summary shall describe the frequency and duration of blasting operations.

7. All materials for submittal to the Service shall be sent to the Washington Fish and Wildlife Office in Lacey, Washington (Attn: Ryan McReynolds, Federal Activities Branch).

We expect that the amount or extent of incidental take described above will not be exceeded as a result of the proposed action. The RPMs, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the RPMs. The FHWA must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the RPMs.

The Service is to be notified within three working days upon locating a dead, injured or sick endangered or threatened species specimen. Initial notification must be made to the nearest U.S. Fish and Wildlife Service Law Enforcement Office. Notification must include the date, time, precise location of the injured animal or carcass, and any other pertinent information. Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of sick or injured endangered or threatened species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed. Contact the U.S. Fish and Wildlife Service Law Enforcement Office at (425) 883-8122, or the Service's Washington Fish and Wildlife Office at (360) 753-9440.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service recommends the following to the FHWA:

1. The FHWA, WSDOT, and County should continue scoping and evaluating permanent solutions for other environmental deficiencies along Index-Galena Road and the North Fork Skykomish River. These solutions should take into consideration the effects of future climate change, which are likely to further exacerbate flooding and bed and bank instability throughout the middle and upper watershed. These effects could heighten existing river-road conflicts, create new conflicts, and further degrade and fragment the habitats which support bull trout.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects, or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action(s) outlined in the request. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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APPENDIX A:
STATUS OF THE SPECIES: BULL TROUT

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Appendix A
Status of the Species for Bull Trout

Taxonomy

The bull trout (*Salvelinus confluentus*) is a native char found in the coastal and intermountain west of North America. Dolly Varden (*Salvelinus malma)* and bull trout were previously considered a single species and were thought to have coastal and interior forms. However, Cavender (1978, entire) described morphometric, meristic and osteological characteristics of the two forms, and provided evidence of specific distinctions between the two. Despite an overlap in the geographic range of bull trout and Dolly Varden in the Puget Sound area and along the British Columbia coast, there is little evidence of introgression (Haas and McPhail 1991, p. 2191). The Columbia River Basin is considered the region of origin for the bull trout. From the Columbia, dispersal to other drainage systems was accomplished by marine migration and headwater stream capture. Behnke (2002, p. 297) postulated dispersion to drainages east of the continental divide may have occurred through the North and South Saskatchewan Rivers (Hudson Bay drainage) and the Yukon River system. Marine dispersal may have occurred from Puget Sound north to the Fraser, Skeena and Taku Rivers of British Columbia.

Species Description

Bull trout have unusually large heads and mouths for salmonids. Their body colors can vary tremendously depending on their environment, but are often brownish green with lighter (often ranging from pale yellow to crimson) colored spots running along their dorsa and flanks, with spots being absent on the dorsal fin, and light colored to white under bellies. They have white leading edges on their fins, as do other species of char. Bull trout have been measured as large as 103 centimeters (41 inches) in length, with weights as high as 14.5 kilograms (32 pounds) (Fishbase 2015, p. 1). Bull trout may be migratory, moving throughout large river systems, lakes, and even the ocean in coastal populations, or they may be resident, remaining in the same stream their entire lives (Rieman and McIntyre 1993, p. 2; Brenkman and Corbett 2005, p. 1077). Migratory bull trout are typically larger than resident bull trout (USFWS 1998, p. 31668).

Legal Status

The coterminous United States population of the bull trout was listed as threatened on November 1, 1999 (USFWS 1999, entire). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Bond 1992, p. 4; Brewin and Brewin 1997, pp. 209-216; Cavender 1978, pp. 165-166; Leary and Allendorf 1997, pp. 715-720).

Throughout its range, the bull trout are threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (USFWS 1999, p. 58910). Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007, entire; Rieman et al. 2007, entire; Porter and Nelitz. 2009, pages 4-8). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

Life History

The iteroparous reproductive strategy of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, p. 30; Pratt 1985, pp. 28-34). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982, p. 95).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989, p. 141). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, pp. 15-16; Pratt 1992, pp. 6-7; Rieman and McIntyre 1996, p. 133). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 1). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, p. 1; Ratliff and Howell 1992, p. 10).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002, p. 9) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007, p. 10). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995, Ch 2 pp. 23-24). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

Population Dymanics

Population Structure

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993, p. 2). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Goetz 1989, p. 15). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, p. 138; Goetz 1989, p. 24), or saltwater (anadromous form) to rear as subadults and to live as adults (Brenkman and Corbett 2005, entire; McPhail and Baxter 1996, p. i; WDFW et al. 1997, p. 16). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, p. 135; Leathe and Graham 1982, p. 95; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133).

Bull trout are naturally migratory, which allows them to capitalize on temporally abundant food resources and larger downstream habitats. Resident forms may develop where barriers (either natural or manmade) occur or where foraging, migrating, or overwintering habitats for migratory fish are minimized (Brenkman and Corbett 2005, pp. 1075-1076; Goetz et al. 2004, p. 105). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002, pp. 96, 98-106). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes. Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, pp. 861-863; MBTSG 1998, p. 13; Rieman and McIntyre 1993, pp. 2-3). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993, p. 2).

Whitesel et al. (2004, p. 2) noted that although there are multiple resources that contribute to the subject, Spruell et al. (2003, entire) best summarized genetic information on bull trout population structure. Spruell et al. (2003, entire) analyzed 1,847 bull trout from 65 sampling locations, four located in three coastal drainages (Klamath, Queets, and Skagit Rivers), one in the Saskatchewan

River drainage (Belly River), and 60 scattered throughout the Columbia River Basin. They concluded that there is a consistent pattern among genetic studies of bull trout, regardless of whether examining allozymes, mitochondrial DNA, or most recently microsatellite loci. Typically, the genetic pattern shows relatively little genetic variation within populations, but substantial divergence among populations. Microsatellite loci analysis supports the existence of at least three major genetically differentiated groups (or evolutionary lineages) of bull trout (Spruell et al. 2003, p. 17). They were characterized as:

i. "Coastal", including the Deschutes River and all of the Columbia River drainage downstream, as well as most coastal streams in Washington, Oregon, and British Columbia. A compelling case also exists that the Klamath Basin represents a unique evolutionary lineage within the coastal group.

ii. "Snake River", which also included the John Day, Umatilla, and Walla Walla rivers. Despite close proximity of the John Day and Deschutes Rivers, a striking level of divergence between bull trout in these two systems was observed.

iii. "Upper Columbia River" which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell et al. (2003, p. 25) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.

Spruell et al. (2003, p. 17) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor et al. (1999, entire) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello et al. (2003, p. 328) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Spruell et al. (2003, p. 26) and the biogeographic analysis of Haas and McPhail (2001, entire). Both Taylor et al. (1999, p. 1166) and Spruell et al. (2003, p. 21) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

More recently, the U.S. Fish and Wildlife Service (Service) identified additional genetic units within the coastal and interior lineages (Ardren et al. 2011, p. 18). Based on a recommendation in the Service's 5-year review of the species' status (USFWS 2008a, p. 45), the Service reanalyzed the 27 recovery units identified in the draft bull trout recovery plan (USFWS 2002a, p. 48) by utilizing, in part, information from previous genetic studies and new information from additional analysis (Ardren et al. 2011, entire). In this examination, the Service applied relevant factors from the joint Service and National Marine Fisheries Service Distinct Population Segment (DPS) policy (USFWS 1996, entire) and subsequently identified six draft recovery units that contain assemblages of core areas that retain genetic and ecological integrity across the range of bull trout in the coterminous United States. These six draft recovery units were used to inform designation of critical habitat for bull trout by providing a context for deciding what habitats are essential for recovery (USFWS 2010, p. 63898). The six draft recovery units identified for bull trout in the coterminous United States include: Coastal, Klamath, Mid-Columbia, Columbia Headwaters, Saint Mary, and Upper Snake. These six draft recovery units were also identified in the Service's revised recovery plan (USFWS 2015, p. vii) and designated as final recovery units.

Population Dynamics

Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, p. 4). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders et al. 1991, entire). Burkey (1989, entire) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989, entire; Burkey 1995, entire).

Metapopulation concepts of conservation biology theory have been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993, p. 15; Dunham and Rieman 1999, entire; Rieman and Dunham 2000, entire). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994, pp. 189-190). For inland bull trout, metapopulation theory is likely most applicable at the watershed scale where habitat consists of discrete patches or collections of habitat capable of supporting local populations; local populations are for the most part independent and represent discrete reproductive units; and long-term, low-rate dispersal patterns among component populations influences the persistence of at least some of the local populations (Rieman and Dunham 2000, entire). Ideally, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. However, habitat alteration, primarily through the construction of impoundments, dams, and water diversions has fragmented habitats, eliminated migratory corridors, and in many cases isolated bull trout in the headwaters of tributaries (Rieman and Clayton 1997, pp. 10-12; Dunham and Rieman 1999, p. 645; Spruell et al. 1999, pp. 118-120; Rieman and Dunham 2000, p. 55).

Human-induced factors as well as natural factors affecting bull trout distribution have likely limited the expression of the metapopulation concept for bull trout to patches of habitat within the overall distribution of the species (Dunham and Rieman 1999, entire). However, despite the theoretical fit, the relatively recent and brief time period during which bull trout investigations have taken place does not provide certainty as to whether a metapopulation dynamic is occurring (e.g., a balance between local extirpations and recolonizations) across the range of the bull trout or whether the persistence of bull trout in large or closely interconnected habitat patches (Dunham and Rieman 1999, entire) is simply reflective of a general deterministic trend towards extinction of the species where the larger or interconnected patches are relics of historically wider distribution (Rieman and Dunham 2000, pp. 56-57). Recent research (Whiteley et al. 2003, entire) does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho.

Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993, p. 4). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, entire; Goetz 1989, pp. 23, 25; Hoelscher and Bjornn 1989, pp. 19, 25; Howell and Buchanan 1992, pp. 30, 32; Pratt 1992, entire; Rich 1996, p. 17; Rieman and McIntyre 1993, pp. 4-6; Rieman and McIntyre 1995, entire; Sedell and Everest 1991, entire; Watson and Hillman 1997, entire). Watson and Hillman (1997, pp. 247-250) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993, pp. 4-6), bull trout should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993, p. 2). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, p. 2; Spruell et al. 1999, entire). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under "Diet."

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams, and spawning habitats are generally characterized by temperatures that drop below 9 °C in the fall (Fraley and Shepard 1989, p. 137; Pratt 1992, p. 5; Rieman and McIntyre 1993, p. 2).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, pp 7-8; Rieman and McIntyre 1993, p. 7). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (Buchanan and Gregory 1997, p. 4; Goetz 1989, p. 22). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996, entire) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C, within a temperature gradient of 8 °C to 15 °C. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003, p. 900) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C.

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, p. 2; Fraley and Shepard 1989, pp. 133, 135; Rieman and McIntyre 1993, pp. 3-4; Rieman and McIntyre 1995, p. 287). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick 2002, pp. 6 and 13).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, p. 137; Goetz 1989, p. 19; Hoelscher and Bjornn 1989, p. 38; Pratt 1992, entire; Rich 1996, pp. 4-5; Sedell and Everest 1991, entire; Sexauer and James 1997, entire; Thomas 1992, pp. 4-6; Watson and Hillman 1997, p. 238). Maintaining bull trout habitat requires natural stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993, pp. 5-6). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, p. 364). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, p. 141; Pratt 1992, p. 6; Pratt and Huston 1993, p. 70). Pratt (1992, p. 6) indicated that increases in fine sediment reduce egg survival and emergence.

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Fish growth depends on the quantity and quality of food that is eaten, and as fish grow their foraging strategy changes as their food changes, in quantity, size, or other characteristics (Quinn 2005, pp. 195-200). Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, p. 58; Donald and Alger 1993, pp. 242-243; Goetz 1989, pp. 33-34). Subadult and adult migratory bull trout feed on various fish species (Donald and Alger 1993, pp. 241-243; Fraley and Shepard 1989, pp. 135, 138; Leathe and Graham 1982, pp. 13, 50-56). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001, p. 204). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004, p. 105; WDFW et al. 1997, p. 23).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997, p. 25). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005, pp. 1078-1079; Goetz et al. 2004, entire).

Status and Distribution

Distribution and Demography

The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978, pp. 165-166; Bond 1992, p. 2). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992, p. 2). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Cavender 1978, pp. 165-166; Brewin et al. 1997, entire).

Each of the following recovery units (below) is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions. No new local populations have been identified and no local populations have been lost since listing.

Coastal Recovery Unit

The Coastal Recovery Unit is located within western Oregon and Washington. Major geographic regions include the Olympic Peninsula, Puget Sound, and Lower Columbia River basins. The Olympic Peninsula and Puget Sound geographic regions also include their associated marine waters (Puget Sound, Hood Canal, Strait of Juan de Fuca, and Pacific Coast), which are critical in supporting the anadromous[1] life history form, unique to the Coastal Recovery Unit. The Coastal Recovery Unit is also the only unit that overlaps with the distribution of Dolly Varden (*Salvelinus malma*) (Ardren *et al.* 2011), another native char species that looks very similar to the bull trout (Haas and McPhail 1991). The two species have likely had some level of historic introgression in this part of their range (Redenbach and Taylor 2002). The Lower Columbia River major geographic region includes the lower mainstem Columbia River, an important migratory waterway essential for providing habitat and population connectivity within this region. In the Coastal Recovery Unit, there are 21 existing bull trout core areas which have been designated, including the recently reintroduced Clackamas River population, and 4 core areas have been identified that could be re-established. Core areas within the recovery unit are distributed among these three major geographic regions (Puget Sound also includes one core area that is actually part of the lower Fraser River system in British Columbia, Canada) (USFWS 2015a, p. A-1).

The current demographic status of bull trout in the Coastal Recovery Unit is variable across the unit. Populations in the Puget Sound region generally tend to have better demographic status, followed by the Olympic Peninsula, and finally the Lower Columbia River region. However, population strongholds do exist across the three regions. The Lower Skagit River and Upper Skagit River core areas in the Puget Sound region likely contain two of the most abundant bull trout populations with some of the most intact habitat within this recovery unit. The Lower Deschutes River core area in the Lower Columbia River region also contains a very abundant bull trout population and has been used as a donor stock for re-establishing the Clackamas River population (USFWS 2015a, p. A-6).

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[1] Anadromous: Life history pattern of spawning and rearing in fresh water and migrating to salt water areas to mature.

Puget Sound Region

In the Puget Sound region, bull trout populations are concentrated along the eastern side of Puget Sound with most core areas concentrated in central and northern Puget Sound.

Although the Chilliwack River core area is considered part of this region, it is technically connected to the Fraser River system and is transboundary with British Columbia making its distribution unique within the region. Most core areas support a mix of anadromous and fluvial life history forms, with at least two core areas containing a natural adfluvial life history (Chilliwack River core area [Chilliwack Lake] and Chester Morse Lake core area). Overall demographic status of core areas generally improves as you move from south Puget Sound to north Puget Sound. Although comprehensive trend data are lacking, the current condition of core areas within this region are likely stable overall, although some at depressed abundances. Two core areas (Puyallup River and Stillaguamish River) contain local populations at either very low abundances (Upper Puyallup and Mowich Rivers) or that have likely become locally extirpated (Upper Deer Creek, South Fork Canyon Creek, and Greenwater River). Connectivity among and within core areas of this region is generally intact. Most core areas in this region still have significant amounts of headwater habitat within protected and relatively pristine areas (e.g., North Cascades National Park, Mount Rainier National Park, Skagit Valley Provincial Park, Manning Provincial Park, and various wilderness or recreation areas) (USFWS 2015a, p. A-7).

Olympic Peninsula Region

In the Olympic Peninsula region, distribution of core areas is somewhat disjunct, with only one located on the west side of Hood Canal on the eastern side of the peninsula, two along the Strait of Juan de Fuca on the northern side of the peninsula, and three along the Pacific Coast on the western side of the peninsula. Most core areas support a mix of anadromous and fluvial life history forms, with at least one core area also supporting a natural adfluvial life history (Quinault River core area [Quinault Lake]). Demographic status of core areas is poorest in Hood Canal and Strait of Juan de Fuca, while core areas along the Pacific Coast of Washington likely have the best demographic status in this region. The connectivity between core areas in these disjunct regions is believed to be naturally low due to the geographic distance between them.

Internal connectivity is currently poor within the Skokomish River core area (Hood Canal) and is being restored in the Elwha River core area (Strait of Juan de Fuca). Most core areas in this region still have their headwater habitats within relatively protected areas (Olympic National Park and wilderness areas) (USFWS 2015a, p. A-7).

Lower Columbia River Region

In the Lower Columbia River region, the majority of core areas are distributed along the Cascade Crest on the Oregon side of the Columbia River. Only two of the seven core areas in this region are in Washington. Most core areas in the region historically supported a fluvial life history form, but many are now adfluvial due to reservoir construction. However, there is at least one core area supporting a natural adfluvial life history (Odell Lake) and one supporting a natural, isolated, resident life history (Klickitat River [West Fork Klickitat]). Status is highly variable across this region, with one relative stronghold (Lower Deschutes core area) existing on the Oregon side of the Columbia River. The Lower Columbia River region also contains three watersheds (North Santiam River, Upper Deschutes River, and White Salmon River) that could potentially become re-established core areas within the Coastal Recovery Unit. Although the South Santiam River has been identified as a historic core area, there remains uncertainty as to whether or not historical observations of bull trout represented a self-sustaining population. Current habitat conditions in the South Santiam River are thought to be unable to support bull trout spawning and rearing. Adult abundances within the majority of core areas in this region are relatively low, generally 300 or fewer individuals.

Most core populations in this region are not only isolated from one another due to dams or natural barriers, but they are internally fragmented as a result of manmade barriers. Local populations are often disconnected from one another or from potential foraging habitat. In the Coastal Recovery Unit, adult abundance may be lowest in the Hood River and Odell Lake core areas, which each contain fewer than 100 adults. Bull trout were reintroduced in the Middle Fork Willamette River in 1990 above Hills Creek Reservoir. Successful reproduction was first documented in 2006, and has occurred each year since (USFWS 2015a, p. A-8). Natural reproducing populations of bull trout are present in the McKenzie River basin (USFWS 2008d, pp. 65-67). Bull trout were more recently reintroduced into the Clackamas River basin in the summer of 2011 after an extensive feasibility analysis (Shively et al. 2007, Hudson et al. 2015). Bull trout from the Lower Deschutes core area are being utilized for this reintroduction effort (USFWS 2015a, p. A-8).

Klamath Recovery Unit

Bull trout in the Klamath Recovery Unit have been isolated from other bull trout populations for the past 10,000 years and are recognized as evolutionarily and genetically distinct (Minckley et al. 1986; Leary et al. 1993; Whitesel et al. 2004; USFWS 2008a; Ardren et al. 2011). As such, there is no opportunity for bull trout in another recovery unit to naturally re- colonize the Klamath Recovery Unit if it were to become extirpated. The Klamath Recovery Unit lies at the southern edge of the species range and occurs in an arid portion of the range of bull trout.

Bull trout were once widespread within the Klamath River basin (Gilbert 1897; Dambacher et al. 1992; Ziller 1992; USFWS 2002b), but habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, and past fisheries management practices have greatly reduced their distribution. Bull trout abundance also has been severely reduced, and the remaining populations are highly fragmented and vulnerable to natural or manmade factors that place them at a high risk of extirpation (USFWS 2002b). The presence of nonnative brook trout (*Salvelinus fontinalis*), which compete and hybridize with bull trout, is a particular threat to bull trout persistence throughout the Klamath Recovery Unit (USFWS 2015b, pp. B-3-4).

Upper Klamath Lake Core Area

The Upper Klamath Lake core area comprises two bull trout local populations (Sun Creek and Threemile Creek). These local populations likely face an increased risk of extirpation because they are isolated and not interconnected with each other. Extirpation of other local populations in the Upper Klamath Lake core area has occurred in recent times (1970s). Populations in this core area are genetically distinct from those in the other two core areas in the Klamath Recovery Unit (USFWS 2008b), and in comparison, genetic variation within this core area is lowest. The two local populations have been isolated by habitat fragmentation and have experienced population bottlenecks. As such, currently unoccupied habitat is needed to restore connectivity between the two local populations and to establish additional populations. This unoccupied habitat includes canals, which now provide the only means of connectivity as migratory corridors. Providing full volitional connectivity for bull trout, however, also introduces the risk of invasion by brook trout, which are abundant in this core area.

Bull trout in the Upper Klamath Lake core area formerly occupied Annie Creek, Sevenmile Creek, Cherry Creek, and Fort Creek, but are now extirpated from these locations. The last remaining local populations, Sun Creek and Threemile Creek, have received focused attention. Brook trout have been removed from bull trout occupied reaches, and these reaches have been intentionally isolated to prevent brook trout reinvasion. As such, over the past few generations these populations have become stable and have increased in distribution and abundance. In 1996, the Threemile Creek population had approximately 50 fish that occupied a 1.4-km (0.9-mile) reach (USFWS 2002b). In 2012, a mark-resight population estimate was completed in Threemile Creek, which indicated an abundance of 577 (95 percent confidence interval = 475 to 679) age-1+ fish (ODFW 2012). In addition, the length of the distribution of bull trout in Threemile Creek had increased to 2.7 km (1.7 miles) by 2012 (USFWS unpublished data). Between 1989 and 2010, bull trout abundance in Sun Creek increased approximately tenfold (from approximately 133 to 1,606 age-1+ fish) and distribution increased from approximately 1.9 km (1.2 miles) to 11.2 km (7.0 miles) (Buktenica et al. 2013) (USFWS 2015b, p. B-5).

Sycan River Core Area

The Sycan River core area is comprised of one local population, Long Creek. Long Creek likely faces greater risk of extirpation because it is the only remaining local population due to extirpation of all other historic local populations. Bull trout previously occupied Calahan Creek, Coyote Creek, and the Sycan River, but are now extirpated from these locations (Light et al. 1996). This core area's local population is genetically distinct from those in the other two core areas (USFWS 2008b). This core area also is essential for recovery because bull trout in this core area exhibit both resident[2] and fluvial life histories, which are important for representing diverse life history expression in the Klamath Recovery Unit. Migratory bull trout are able to grow larger than their resident

[2] Resident: Life history pattern of residing in tributary streams for the fish's entire life without migrating.

counterparts, resulting in greater fecundity and higher reproductive potential (Rieman and McIntyre 1993). Migratory life history forms also have been shown to be important for population persistence and resilience (Dunham et al. 2008).

The last remaining population (Long Creek) has received focused attention in an effort to ensure it is not also extirpated. In 2006, two weirs were removed from Long Creek, which increased the amount of occupied foraging, migratory, and overwintering (FMO) habitat by 3.2 km (2.0 miles). Bull trout currently occupy approximately 3.5 km (2.2 miles) of spawning/rearing habitat, including a portion of an unnamed tributary to upper Long Creek, and seasonally use 25.9 km (16.1 miles) of FMO habitat. Brook trout also inhabit Long Creek and have been the focus of periodic removal efforts. No recent statistically rigorous population estimate has been completed for Long Creek; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 842 individuals (USFWS 2002b). Currently unoccupied habitat is needed to establish additional local populations, although brook trout are widespread in this core area and their management will need to be considered in future recovery efforts. In 2014, the Klamath Falls Fish and Wildlife Office of the Service established an agreement with the U.S. Geological Survey to undertake a structured decision making process to assist with recovery planning of bull trout populations in the Sycan River core area (USFWS 2015b, p. B-6).

Upper Sprague River Core Area

The Upper Sprague River core area comprises five bull trout local populations, placing the core area at an intermediate risk of extinction. The five local populations include Boulder Creek, Dixon Creek, Deming Creek, Leonard Creek, and Brownsworth Creek. These local populations may face a higher risk of extirpation because not all are interconnected. Bull trout local populations in this core area are genetically distinct from those in the other two Klamath Recovery Unit core areas (USFWS 2008b). Migratory bull trout have occasionally been observed in the North Fork Sprague River (USFWS 2002b). Therefore, this core area also is essential for recovery in that bull trout here exhibit a resident life history and likely a fluvial life history, which are important for conserving diverse life history expression in the Klamath Recovery Unit as discussed above for the Sycan River core area.

The Upper Sprague River core area population of bull trout has experienced a decline from historic levels, although less is known about historic occupancy in this core area. Bull trout are reported to have historically occupied the South Fork Sprague River, but are now extirpated from this location (Buchanan et al. 1997). The remaining five populations have received focused attention. Although brown trout (*Salmo trutta*) co-occur with bull trout and exist in adjacent habitats, brook trout do not overlap with existing bull trout populations. Efforts have been made to increase connectivity of existing bull trout populations by replacing culverts that create barriers. Thus, over the past few generations, these populations have likely been stable and increased in distribution. Population abundance has been estimated recently for Boulder Creek (372 + 62 percent; Hartill and Jacobs 2007), Dixon Creek (20 + 60 percent; Hartill and Jacobs 2007), Deming Creek (1,316 + 342; Moore 2006), and Leonard Creek (363 + 37 percent;

Hartill and Jacobs 2007). No statistically rigorous population estimate has been completed for the Brownsworth Creek local population; however, the 2002 Draft Bull Trout Recovery Plan reported a population estimate of 964 individuals (USFWS 2002b). Additional local populations need to be established in currently unoccupied habitat within the Upper Sprague River core area, although brook trout are widespread in this core area and will need to be considered in future recovery efforts (USFWS 2015b, p. B-7).

Mid-Columbia Recovery Unit

The Mid-Columbia Recovery Unit (RU) comprises 24 bull trout core areas, as well as 2 historically occupied core areas and 1 research needs area. The Mid-Columbia RU is recognized as an area where bull trout have co-evolved with salmon, steelhead, lamprey, and other fish populations. Reduced fish numbers due to historic overfishing and land management changes have caused changes in nutrient abundance for resident migratory fish like the bull trout. The recovery unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. Major drainages include the Methow River, Wenatchee River, Yakima River, John Day River, Umatilla River, Walla Walla River, Grande Ronde River, Imnaha River, Clearwater River, and smaller drainages along the Snake River and Columbia River (USFWS 2015c, p. C-1).

The Mid-Columbia RU can be divided into four geographic regions the Lower Mid-Columbia, which includes all core areas that flow into the Columbia River below its confluence with the 1) Snake River; 2) the Upper Mid-Columbia, which includes all core areas that flow into the Columbia River above its confluence with the Snake River; 3) the Lower Snake, which includes all core areas that flow into the Snake River between its confluence with the Columbia River and Hells Canyon Dam; and 4) the Mid-Snake, which includes all core areas in the Mid-Columbia RU that flow into the Snake River above Hells Canyon Dam. These geographic regions are composed of neighboring core areas that share similar bull trout genetic, geographic (hydrographic), and/or habitat characteristics. Conserving bull trout in geographic regions allows for the maintenance of broad representation of genetic diversity, provides neighboring core areas with potential source populations in the event of local extirpations, and provides a broad array of options among neighboring core areas to contribute recovery under uncertain environmental change USFWS 2015c, pp. C-1-2).

The current demographic status of bull trout in the Mid-Columbia Recovery Unit is highly variable at both the RU and geographic region scale. Some core areas, such as the Umatilla, Asotin, and Powder Rivers, contain populations so depressed they are likely suffering from the deleterious effects of small population size. Conversely, strongholds do exist within the recovery unit, predominantly in the Lower Snake geographic area. Populations in the Imnaha, Little Minam, Clearwater, and Wenaha Rivers are likely some of the most abundant. These populations are all completely or partially within the bounds of protected wilderness areas and have some of the most intact habitat in the recovery unit. Status in some core areas is relatively unknown, but all indications in these core areas suggest population trends are declining, particularly in the core areas of the John Day Basin (USFWS 2015c, p. C-5).

Lower Mid-Columbia Region

In the Lower Mid-Columbia Region, core areas are distributed along the western portion of the Blue Mountains in Oregon and Washington. Only one of the six core areas is located completely in Washington. Demographic status is highly variable throughout the region. Status is the poorest in the Umatilla and Middle Fork John Day Core Areas. However, the Walla Walla River core area contains nearly pristine habitats in the headwater spawning areas and supports the most abundant populations in the region. Most core areas support both a resident and fluvial life history; however, recent evidence suggests a significant decline in the resident and fluvial life history in the Umatilla River and John Day core areas respectively. Connectivity between the core areas of the Lower Mid-Columbia Region is unlikely given conditions in the connecting FMO habitats. Connection between the Umatilla, Walla Walla and Touchet core areas is uncommon but has been documented, and connectivity is possible between core areas in the John Day Basin. Connectivity between the John Day core areas and Umatilla/Walla Walla/Touchet core areas is unlikely (USFWS 2015c, pp. C-5-6).

Upper Mid-Columbia Region

In the Upper Mid-Columbia Region, core areas are distributed along the eastern side of the Cascade Mountains in Central Washington. This area contains four core areas (Yakima, Wenatchee, Entiat, and Methow), the Lake Chelan historic core area, and the Chelan River, Okanogan River, and Columbia River FMO areas. The core area populations are generally considered migratory, though they currently express both migratory (fluvial and adfluvial) and resident forms. Residents are located both above and below natural barriers (*i.e.*, Early Winters Creek above a natural falls; and Ahtanum in the Yakima likely due to long lack of connectivity from irrigation withdrawal). In terms of uniqueness and connectivity, the genetics baseline, radio-telemetry, and PIT tag studies identified unique local populations in all core areas. Movement patterns within the core areas; between the lower river, lakes, and other core areas; and between the Chelan, Okanogan, and Columbia River FMO occurs regularly for some of the Wenatchee, Entiat, and Methow core area populations. This type of connectivity has been displayed by one or more fish, typically in non-spawning movements within FMO. More recently, connectivity has been observed between the Entiat and Yakima core areas by a juvenile bull trout tagged in the Entiat moving in to the Yakima at Prosser Dam and returning at an adult size back to the Entiat. Genetics baselines identify unique populations in all four core areas (USFWS 2015c, p. C-6).

The demographic status is variable in the Upper-Mid Columbia region and ranges from good to very poor. The Service's 2008 5-year Review and Conservation Status Assessment described the Methow and Yakima Rivers at risk, with a rapidly declining trend. The Entiat River was listed at risk with a stable trend, and the Wenatchee River as having a potential risk, and with a stable trend. Currently, the Entiat River is considered to be declining rapidly due to much reduced redd counts. The Wenatchee River is able to exhibit all freshwater life histories with connectivity to Lake Wenatchee, the Wenatchee River and all its local populations, and to the Columbia River and/or other core areas in the region. In the Yakima core area some populations exhibit life history forms different from what they were historically. Migration between local populations and to and from spawning habitat is generally prevented or impeded by headwater storage dams on irrigation reservoirs, connectivity between tributaries and reservoirs, and within lower portions of spawning and rearing habitat and the mainstem Yakima River due to changed flow patterns, low instream flows, high water temperatures, and other habitat impediments. Currently, the connectivity in the Yakima Core area is truncated to the degree that not all populations are able to contribute gene flow to a functional metapopulation (USFWS 2015c, pp. C-6-7)

Lower Snake Region

Demographic status is variable within the Lower Snake Region. Although trend data are lacking, several core areas in the Grande Ronde Basin and the Imnaha core area are thought to be stable. The upper Grande Ronde Core Area is the exception where population abundance is considered depressed. Wenaha, Little Minam, and Imnaha Rivers are strongholds (as mentioned above), as are most core areas in the Clearwater River basin. Most core areas contain populations that express both a resident and fluvial life history strategy. There is potential that some bull trout in the upper Wallowa River are adfluvial. There is potential for connectivity between core areas in the Grande Ronde basin, however conditions in FMO are limiting (USFWS 2015c, p. C-7).

Middle Snake Region

In the Middle Snake Region, core areas are distributed along both sides of the Snake River above Hells Canyon Dam. The Powder River and Pine Creek basins are in Oregon and Indian Creek and Wildhorse Creek are on the Idaho side of the Snake River. Demographic status of the core areas is poorest in the Powder River Core Area where populations are highly fragmented and severely depressed. The East Pine Creek population in the Pine-Indian-Wildhorse Creeks core area is likely the most abundant within the region. Populations in both core areas primarily express a resident life history strategy; however, some evidence suggests a migratory life history still exists in the Pine-Indian-Wildhorse Creeks core area. Connectivity is severely impaired in the Middle Snake Region. Dams, diversions and temperature barriers prevent movement among populations and between core areas. Brownlee Dam isolates bull trout in Wildhorse Creek from other populations (USFWS 2015c, p. C-7).

Columbia Headwaters Recovery Unit

The Columbia Headwaters Recovery Unit (CHRU) includes western Montana, northern Idaho, and the northeastern corner of Washington. Major drainages include the Clark Fork River basin and its Flathead River contribution, the Kootenai River basin, and the Coeur d'Alene Lake basin. In this implementation plan for the CHRU we have slightly reorganized the structure from the 2002 Draft Recovery Plan, based on latest available science and fish passage improvements that have rejoined previously fragmented habitats. We now identify 35 bull trout core areas (compared to 47 in 2002) for this recovery unit. Fifteen of the 35 are referred to as "complex" core areas as they represent large interconnected habitats, each containing multiple spawning streams considered to host separate and largely genetically identifiable local populations. The 15 complex core areas contain the majority of individual bull trout and the bulk of the designated critical habitat (USFWS 2010).

However, somewhat unique to this recovery unit is the additional presence of 20 smaller core areas, each represented by a single local population. These "simple" core areas are found in remote glaciated headwater basins, often in Glacier National Park or federally-designated wilderness areas, but occasionally also in headwater valley bottoms. Many simple core areas are upstream of waterfalls or other natural barriers to fish migration. In these simple core areas bull trout have apparently persisted for thousands of years despite small populations and isolated existence. As such, simple core areas meet the criteria for core area designation and continue to be valued for their uniqueness, despite limitations of size and scope. Collectively, the 20 simple core areas contain less than 3 percent of the total bull trout core area habitat in the CHRU, but represent significant genetic and life history diversity (Meeuwig et al. 2010). Throughout this recovery unit implementation plan, we often separate our analyses to distinguish between complex and simple core areas, both in respect to threats as well as recovery actions (USFWS 2015d, pp. D-1-2).

In order to effectively manage the recovery unit implementation plan (RUIP) structure in this large and diverse landscape, the core areas have been separated into the following five natural geographic assemblages.

Upper Clark Fork Geographic Region

Starting at the Clark Fork River headwaters, the *Upper Clark Fork Geographic Region* comprises seven complex core areas, each of which occupies one or more major watersheds contributing to the Clark Fork basin (*i.e.*, Upper Clark Fork River, Rock Creek, Blackfoot River, Clearwater River and Lakes, Bitterroot River, West Fork Bitterroot River, and Middle Clark Fork River core areas) (USFWS 2015d, p. D-2).

Lower Clark Fork Geographic Region

The seven headwater core areas flow into the *Lower Clark Fork Geographic Region*, which comprises two complex core areas, Lake Pend Oreille and Priest Lake. Because of the systematic and jurisdictional complexity (three States and a Tribal entity) and the current degree of migratory fragmentation caused by five mainstem dams, the threats and recovery actions in the Lake Pend Oreille (LPO) core area are very complex and are described in three parts. LPO-A is upstream of Cabinet Gorge Dam, almost entirely in Montana, and includes the mainstem Clark Fork River upstream to the confluence of the Flathead River as well as the portions of the lower Flathead River (*e.g.*, Jocko River) on the Flathead Indian Reservation. LPO-B is the Pend Oreille lake basin proper and its tributaries, extending between Albeni Falls Dam downstream from the outlet of Lake Pend Oreille and Cabinet Gorge Dam just upstream of the lake; almost entirely in Idaho. LPO-C is the lower basin (*i.e.*, lower Pend Oreille River), downstream of Albeni Falls Dam to Boundary Dam (1 mile upstream from the Canadian border) and bisected by Box Canyon Dam; including portions of Idaho, eastern Washington, and the Kalispel Reservation (USFWS 2015d, p. D-2).

Historically, and for current purposes of bull trout recovery, migratory connectivity among these separate fragments into a single entity remains a primary objective.

Flathead Geographic Region

The *Flathead Geographic Region* includes a major portion of northwestern Montana upstream of Kerr Dam on the outlet of Flathead Lake. The complex core area of Flathead Lake is the hub of this area, but other complex core areas isolated by dams are Hungry Horse Reservoir (formerly South Fork Flathead River) and Swan Lake. Within the glaciated basins of the Flathead River headwaters are 19 simple core areas, many of which lie in Glacier National Park or the Bob Marshall and Great Bear Wilderness areas and some of which are isolated by natural barriers or other features (USFWS 2015d, p. D-2).

Kootenai Geographic Region

To the northwest of the Flathead, in an entirely separate watershed, lies the *Kootenai Geographic Region*. The Kootenai is a uniquely patterned river system that originates in southeastern British Columbia, Canada. It dips, in a horseshoe configuration, into northwest Montana and north Idaho before turning north again to re-enter British Columbia and eventually join the Columbia River headwaters in British Columbia. The *Kootenai Geographic Region* contains two complex core areas (Lake Koocanusa and the Kootenai River) bisected since the 1970's by Libby Dam, and also a single naturally isolated simple core area (Bull Lake). Bull trout in both of the complex core areas retain strong migratory connections to populations in British Columbia (USFWS 2015d, p. D-3).

Coeur d'Alene Geographic Region

Finally, the *Coeur d'Alene Geographic Region* consists of a single, large complex core area centered on Coeur d'Alene Lake. It is grouped into the CHRU for purposes of physical and ecological similarity (adfluvial bull trout life history and nonanadromous linkage) rather than due to watershed connectivity with the rest of the CHRU, as it flows into the mid-Columbia River far downstream of the Clark Fork and Kootenai systems (USFWS 2015d, p. D-3).

Upper Snake Recovery Unit

The Upper Snake Recovery Unit includes portions of central Idaho, northern Nevada, and eastern Oregon. Major drainages include the Salmon River, Malheur River, Jarbidge River, Little Lost River, Boise River, Payette River, and the Weiser River. The Upper Snake Recovery Unit contains 22 bull trout core areas within 7 geographic regions or major watersheds: Salmon River (10 core areas, 123 local populations), Boise River (2 core areas, 29 local populations), Payette River (5 core areas, 25 local populations), Little Lost River (1 core area, 10 local populations), Malheur River (2 core areas, 8 local populations), Jarbidge River (1 core area, 6 local populations), and Weiser River (1 core area, 5 local populations). The Upper Snake Recovery Unit includes a total of 206 local populations, with almost 60 percent being present in the Salmon River watershed (USFWS 2015e, p. E-1).

Three major bull trout life history expressions are present in the Upper Snake Recovery Unit, adfluvial[3], fluvial[4], and resident populations. Large areas of intact habitat exist primarily in the Salmon drainage, as this is the only drainage in the Upper Snake Recovery Unit that still flows directly into the Snake River; most other drainages no longer have direct connectivity due to irrigation uses or instream barriers. Bull trout in the Salmon basin share a genetic past with bull trout elsewhere in the Upper Snake Recovery Unit. Historically, the Upper Snake Recovery Unit is believed to have largely supported the fluvial life history form; however, many core areas are now isolated or have become fragmented watersheds, resulting in replacement of the fluvial life history with resident or adfluvial forms. The Weiser River, Squaw Creek, Pahsimeroi River, and North Fork Payette River core areas contain only resident populations of bull trout (USFWS 2015e, pp. E-1-2).

Salmon River

The Salmon River basin represents one of the few basins that are still free-flowing down to the Snake River. The core areas in the Salmon River basin do not have any major dams and a large extent (approximately 89 percent) is federally managed, with large portions of the Middle Fork Salmon River and Middle Fork Salmon River - Chamberlain core areas occurring within the Frank Church River of No Return Wilderness. Most core areas in the Salmon River basin contain large populations with many occupied stream segments. The Salmon River basin contains 10 of the 22 core areas in the Upper Snake Recovery Unit and contains the majority of the occupied habitat. Over 70 percent of occupied habitat in the Upper Snake Recovery Unit occurs in the Salmon River basin as well as 123 of the 206 local populations. Connectivity between core areas in the Salmon River basin is intact; therefore it is possible for fish in the mainstem Salmon to migrate to almost any Salmon River core area or even the Snake River.

Connectivity within Salmon River basin core areas is mostly intact except for the Pahsimeroi River and portions of the Lemhi River. The Upper Salmon River, Lake Creek, and Opal Lake core areas contain adfluvial populations of bull trout, while most of the remaining core areas contain fluvial populations; only the Pahsimeroi contains strictly resident populations. Most core areas appear to have increasing or stable trends but trends are not known in the Pahsimeroi, Lake Creek, or Opal Lake core areas. The Idaho Department of Fish and Game reported trend data from 7 of the 10 core areas. This trend data indicated that populations were stable or increasing in the Upper Salmon River, Lemhi River, Middle Salmon River-Chamberlain, Little Lost River, and the South Fork Salmon River (IDFG 2005, 2008). Trends were stable or decreasing in the Little-Lower Salmon River, Middle Fork Salmon River, and the Middle Salmon River-Panther (IDFG 2005, 2008).

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[3] Adfluvial: Life history pattern of spawning and rearing in tributary streams and migrating to lakes or reservoirs to mature.

[4] Fluvial: Life history pattern of spawning and rearing in tributary streams and migrating to larger rivers to mature.

Boise River

In the Boise River basin, two large dams are impassable barriers to upstream fish movement: Anderson Ranch Dam on the South Fork Boise River, and Arrowrock Dam on the mainstem Boise River. Fish in Anderson Ranch Reservoir have access to the South Fork Boise River upstream of the dam. Fish in Arrowrock Reservoir have access to the North Fork Boise River, Middle Fork Boise River, and lower South Fork Boise River. The Boise River basin contains 2 of the 22 core areas in the Upper Snake Recovery Unit. The core areas in the Boise River basin account for roughly 12 percent of occupied habitat in the Upper Snake Recovery Unit and contain 29 of the 206 local populations. Approximately 90 percent of both Arrowrock and Anderson Ranch core areas are federally owned; most lands are managed by the U.S. Forest Service, with some portions occurring in designated wilderness areas. Both the Arrowrock core area and the Anderson Ranch core area are isolated from other core areas. Both core areas contain fluvial bull trout that exhibit adfluvial characteristics and numerous resident populations. The Idaho Department of Fish and Game in 2014 determined that the Anderson Ranch core area had an increasing trend while trends in the Arrowrock core area is unknown (USFWS 2015e).

Payette River

The Payette River basin contains three major dams that are impassable barriers to fish: Deadwood Dam on the Deadwood River, Cascade Dam on the North Fork Payette River, and Black Canyon Reservoir on the Payette River. Only the Upper South Fork Payette River and the Middle Fork Payette River still have connectivity, the remaining core areas are isolated from each other due to dams. Both fluvial and adfluvial life history expression are still present in the Payette River basin but only resident populations are present in the Squaw Creek and North Fork Payette River core areas. The Payette River basin contains 5 of the 22 core areas and 25 of the 206 local populations in the recovery unit. Less than 9 percent of occupied habitat in the recovery unit is in this basin. Approximately 60 percent of the lands in the core areas are federally owned and the majority is managed by the U.S. Forest Service. Trend data are lacking and the current condition of the various core areas is unknown, but there is concern due to the current isolation of three (North Fork Payette River, Squaw Creek, Deadwood River) of the five core areas; the presence of only resident local populations in two (North Fork Payette River, Squaw Creek) of the five core areas; and the relatively low numbers present in the North Fork core area (USFWS 2015e, p. E-8).

Jarbidge River

The Jarbidge River core area contains two major fish barriers along the Bruneau River: the Buckaroo diversion and C. J. Strike Reservoir. Bull trout are not known to migrate down to the Snake River. There is one core area in the basin, with populations in the Jarbidge River; this watershed does not contain any barriers. Approximately 89 percent of the Jarbidge core area is federally owned. Most lands are managed by either the Forest Service or Bureau of Land Management. A large portion of the core area is within the Bruneau-Jarbidge Wilderness area. A tracking study has documented bull trout population connectivity among many of the local populations, in particular between West Fork Jarbidge River and Pine Creek. Movement between the East and West Fork Jarbidge River has also been documented; therefore both resident and fluvial populations are present. The core area contains six local populations and 3 percent of the occupied habitat in the recovery unit. Trend data are lacking within this core area (USFWS 2015e, p. E-9).

Little Lost River

The Little Lost River basin is unique in that the watershed is within a naturally occurring hydrologic sink and has no connectivity with other drainages. A small fluvial population of bull trout may still exist, but it appears that most populations are predominantly resident populations. There is one core area in the Little Lost basin, and approximately 89 percent of it is federally owned by either the U.S. Forest Service or Bureau of Land Management. The core area contains 10 local populations and less than 3 percent of the occupied habitat in the recovery unit. The current trend condition of this core area is likely stable, with most bull trout residing in Upper Sawmill Canyon (IDFG 2014).

Malheur River

The Malheur River basin contains major dams that are impassable to fish. The largest are Warm Springs Dam, impounding Warm Springs Reservoir on the mainstem Malheur River, and Agency Valley Dam, impounding Beulah Reservoir on the North Fork Malheur River. The dams result in two core areas that are isolated from each other and from other core areas. Local populations in the two core areas are limited to habitat in the upper watersheds. The Malheur River basin contains 2 of the 22 core areas and 8 of the 206 local populations in the recovery unit. Fluvial and resident populations are present in both core areas while adfluvial populations are present in the North Fork Malheur River. This basin contains less than 3 percent of the occupied habitat in the recovery unit, and approximately 60 percent of lands in the two core areas are federally owned. Trend data indicates that populations are declining in both core areas (USFWS 2015e, p. E-9).

Weiser River

The Weiser River basin contains local populations that are limited to habitat in the upper watersheds. The Weiser River basin contains only a single core area that consists of 5 of the 206 local populations in the recovery unit. Local populations occur in only three stream complexes in the upper watershed: 1) Upper Hornet Creek, 2) East Fork Weiser River, and 3) Upper Little Weiser River. These local populations include only resident life histories. This basin contains less than 2 percent of the occupied habitat in the recovery unit, and approximately 44 percent of lands are federally owned. Trend data from the Idaho Department of Fish and Game indicate that the populations in the Weiser core area are increasing (IDFG 2014) but it is considered vulnerable because local populations are isolated and likely do not express migratory life histories (USFWS 2015e, p.E-10).

St. Mary Recovery Unit

The Saint Mary Recovery Unit is located in northwest Montana east of the Continental Divide and includes the U.S. portions of the Saint Mary River basin, from its headwaters to the international boundary with Canada at the 49th parallel. The watershed and the bull trout population are linked to downstream aquatic resources in southern Alberta, Canada; the U.S. portion includes headwater spawning and rearing (SR) habitat in the tributaries and a portion of the FMO habitat in the mainstem of the Saint Mary River and Saint Mary lakes (Mogen and Kaeding 2001).

The Saint Mary Recovery Unit comprises four core areas; only one (Saint Mary River) is a complex core area with five described local bull trout populations (Divide, Boulder, Kennedy, Otatso, and Lee Creeks). Roughly half of the linear extent of available FMO habitat in the mainstem Saint Mary system (between Saint Mary Falls at the upstream end and the downstream Canadian border) is comprised of Saint Mary and Lower Saint Mary Lakes, with the remainder in the Saint Mary River. The other three core areas (Slide Lakes, Cracker Lake, and Red Eagle Lake) are simple core areas. Slide Lakes and Cracker Lake occur upstream of seasonal or permanent barriers and are comprised of genetically isolated single local bull trout populations, wholly within Glacier National Park, Montana. In the case of Red Eagle Lake, physical isolation does not occur, but consistent with other lakes in the adjacent Columbia Headwaters Recovery Unit, there is likely some degree of spatial separation from downstream Saint Mary Lake. As noted, the extent of isolation has been identified as a research need (USFWS 2015f, p. F-1).

Bull trout in the Saint Mary River complex core area are documented to exhibit primarily the migratory fluvial life history form (Mogen and Kaeding 2005a, 2005b), but there is doubtless some occupancy (though less well documented) of Saint Mary Lakes, suggesting a partly adfluvial adaptation. Since lake trout and northern pike are both native to the Saint Mary River system (headwaters of the South Saskatchewan River drainage draining to Hudson Bay), the conventional wisdom is that these large piscivores historically outcompeted bull trout in the lacustrine environment (Donald and Alger 1993, Martinez et al. 2009), resulting in a primarily fluvial niche and existence for bull trout in this system. This is an untested hypothesis and additional research into this aspect is needed (USFWS 2015f, p. F-3).

Bull trout populations in the simple core areas of the three headwater lake systems (Slide, Cracker, and Red Eagle Lakes) are, by definition, adfluvial; there are also resident life history components in portions of the Saint Mary River system such as Lower Otatso Creek (Mogen and Kaeding 2005a), further exemplifying the overall life history diversity typical of bull trout. Mogen and Kaeding (2001) reported that bull trout continue to inhabit nearly all suitable habitats accessible to them in the Saint Mary River basin in the United States. The possible exception is portions of Divide Creek, which appears to be intermittently occupied despite a lack of permanent migratory barriers, possibly due to low population size and erratic year class production (USFWS 2015f, p. F-3).

It should be noted that bull trout are found in minor portions of two additional U.S. watersheds (Belly and Waterton rivers) that were once included in the original draft recovery plan (USFWS 2002) but are no longer considered core areas in the final recovery plan (USFWS 2015) and are not addressed in that document. In Alberta, Canada, the Saint Mary River bull trout population is considered at "high risk," while the Belly River is rated as "at risk" (ACA 2009). In the Belly River drainage, which enters the South Saskatchewan system downstream of the Saint Mary River in Alberta, some bull trout spawning is known to occur on either side of the international boundary. These waters are in the drainage immediately west of the Saint Mary River headwaters. However, the U.S. range of this population constitutes only a minor headwater migratory SR segment of an otherwise wholly Canadian population, extending less than 1 mile (0.6 km) into backcountry waters of Glacier National Park. The Belly River population is otherwise totally dependent on management within Canadian jurisdiction, with no natural migratory connection to the Saint Mary (USFWS 2015f, p. F-3).

Current status of bull trout in the Saint Mary River core area (U.S.) is considered strong (Mogen 2013). Migratory bull trout redd counts are conducted annually in the two major SR streams, Boulder and Kennedy creeks. Boulder Creek redd counts have ranged from 33 to 66 in the past decade, with the last 4 counts all 53 or higher. Kennedy Creek redd counts are less robust, ranging from 5 to 25 over the last decade, with a 2014 count of 20 (USFWS 2015f, p. F-3).

Generally, the demographic status of the Saint Mary River core area is believed to be good, with the exception of the Divide Creek local population. In this local population, there is evidence that a combination of ongoing habitat manipulation (Smillie and Ellerbroek 1991,F-5 NPS 1992) resulting in occasional historical passage issues, combined with low and erratic recruitment (DeHaan et al. 2011) has caused concern for the continuing existence of the local population.

While less is known about the demographic status of the three simple cores where redd counts are not conducted, all three appear to be self-sustaining and fluctuating within known historical population demographic bounds. Of the three simple core areas, demographic status in Slide Lakes and Cracker Lake appear to be functioning appropriately, but the demographic status in Red Eagle Lake is less well documented and believed to be less robust (USFWS 2015f, p. F-3).

Reasons for Listing

Bull trout distribution, abundance, and habitat quality have declined rangewide (Bond 1992, pp. 2-3; Schill 1992, p. 42; Thomas 1992, entire; Ziller 1992, entire; Rieman and McIntyre 1993, p. 1; Newton and Pribyl 1994, pp. 4-5; McPhail and Baxter 1996, p. 1). Several local extirpations have been documented, beginning in the 1950s (Rode 1990, pp. 26-32; Ratliff and Howell 1992, entire; Donald and Alger 1993, entire; Goetz 1994, p. 1; Newton and Pribyl 1994, pp. 8-9; Light et al. 1996, pp. 6-7; Buchanan et al. 1997, p. 15; WDFW 1998, pp. 2-3). Bull trout were extirpated from the southernmost portion of their historic range, the McCloud River in California, around 1975 (Rode 1990, p. 32). Bull trout have been functionally extirpated (i.e., few individuals may occur there but do not constitute a viable population) in the Coeur d'Alene River basin in Idaho and in the Lake Chelan and Okanogan River basins in Washington (USFWS 1998, pp. 31651-31652).

These declines result from the combined effects of habitat degradation and fragmentation, the blockage of migratory corridors; poor water quality, angler harvest and poaching, entrainment (process by which aquatic organisms are pulled through a diversion or other device) into diversion channels and dams, and introduced nonnative species. Specific land and water management activities that depress bull trout populations and degrade habitat include the effects of dams and other diversion structures, forest management practices, livestock grazing, agriculture, agricultural diversions, road construction and maintenance, mining, and urban and rural development (Beschta et al. 1987, entire; Chamberlain et al. 1991, entire; Furniss et al. 1991, entire; Meehan 1991, entire; Nehlsen et al. 1991, entire; Sedell and Everest 1991, entire; Craig and Wissmar 1993pp, 18-19; Henjum et al. 1994, pp. 5-6; McIntosh et al. 1994, entire; Wissmar et al. 1994, entire; MBTSG 1995a, p. 1; MBTSG 1995b. pp. i-ii; MBTSG 1995c, pp. i-ii; MBTSG 1995d, p. 22; MBTSG 1995e, p. i; MBTSG 1996a, p. i-ii; MBTSG 1996b, p. i; MBTSG 1996c, p. i; MBTSG 1996d, p. i; MBTSG 1996e, p. i; MBTSG 1996f, p. 11; Light et al. 1996, pp. 6-7; USDA and USDI 1995, p. 2).

Emerging Threats

<u>Climate Change</u>

Climate change was not addressed as a known threat when bull trout was listed. The 2015 bull trout recovery plan and RUIPs summarize the threat of climate change and acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time due to anthropogenic climate change effects, and use of best available information will ensure future conservation efforts that offer the greatest long-term benefit to sustain bull trout and their required coldwater habitats (USFWS 2015, p. vii, and pp. 17-20, USFWS 2015a-f).

Global climate change and the related warming of global climate have been well documented (IPCC 2007, entire; ISAB 2007, entire; Combes 2003, entire). Evidence of global climate change/warming includes widespread increases in average air and ocean temperatures and accelerated melting of glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (IPCC 2007, p. 253; Battin et al. 2007, p. 6720), we can no longer assume that climate conditions in the future will resemble those in the past.

Patterns consistent with changes in climate have already been observed in the range of many species and in a wide range of environmental trends (ISAB 2007, entire; Hari et al. 2006, entire; Rieman et al. 2007, entire). In the northern hemisphere, the duration of ice cover over lakes and rivers has decreased by almost 20 days since the mid-1800's (Magnuson et al. 2000, p. 1743). The range of many species has shifted poleward and elevationally upward. For cold-water associated salmonids in mountainous regions, where their upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in range, which in turn can lead to a population decline (Hari et al. 2006, entire).

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the seasonal amount of snow pack diminishes, the timing and volume of stream flow are likely to change and peak river flows are likely to increase in affected areas. Higher air temperatures are also likely to increase water temperatures (ISAB 2007, pp. 15-17). For example, stream gauge data from western Washington over the past 5 to 25 years indicate a marked increasing trend in water temperatures in most major rivers.

Climate change has the potential to profoundly alter the aquatic ecosystems upon which the bull trout depends via alterations in water yield, peak flows, and stream temperature, and an increase in the frequency and magnitude of catastrophic wildfires in adjacent terrestrial habitats (Bisson et al. 2003, pp 216-217).

All life stages of the bull trout rely on cold water. Increasing air temperatures are likely to impact the availability of suitable cold water habitat. For example, ground water temperature is generally correlated with mean annual air temperature, and has been shown to strongly influence the distribution of other chars. Ground water temperature is linked to bull trout selection of spawning sites, and has been shown to influence the survival of embryos and early juvenile rearing of bull trout (Baxter 1997, p. 82). Increases in air temperature are likely to be reflected in increases in both surface and groundwater temperatures.

Climate change is likely to affect the frequency and magnitude of fires, especially in warmer drier areas such as are found on the eastside of the Cascade Mountains. Bisson et al. (2003, pp. 216-217) note that the forest that naturally occurred in a particular area may or may not be the forest that will be responding to the fire regimes of an altered climate. In several studies related to the effect of large fires on bull trout populations, bull trout appear to have adapted to past fire disturbances through mechanisms such as dispersal and plasticity. However, as stated earlier, the future may well be different than the past and extreme fire events may have a dramatic effect on bull trout and other aquatic species, especially in the context of continued habitat loss, simplification and fragmentation of aquatic systems, and the introduction and expansion of exotic species (Bisson et al. 2003, pp. 218-219).

Migratory bull trout can be found in lakes, large rivers and marine waters. Effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-warming impacts to lakes will likely lead to longer periods of thermal stratification and coldwater fish such as adfluvial bull trout will be restricted to these bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the bottom layers and intensify competition for food (Shuter and Meisner 1992. p. 11).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change are related to shifts in timing, magnitude and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin et al. 2007, p. 6720). The increased magnitude of winter peak flows in high elevation areas is likely to impact the location, timing, and success of spawning and incubation for the bull trout and Pacific salmon species. Although lower elevation river reaches are not expected to experience as severe an impact from alterations in stream hydrology, they are unlikely to provide suitably cold temperatures for bull trout spawning, incubation and juvenile rearing.

As climate change progresses and stream temperatures warm, thermal refugia will be critical to the persistence of many bull trout populations. Thermal refugia are important for providing bull trout with patches of suitable habitat during migration through or to make feeding forays into areas with greater than optimal temperatures.

There is still a great deal of uncertainty associated with predictions relative to the timing, location, and magnitude of future climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007, p 7) although the scale of that variation may exceed that of States. For example, several studies indicate that climate change has the potential to impact ecosystems in nearly all streams throughout the State of Washington (ISAB 2007, p. 13; Battin et al. 2007, p. 6722; Rieman et al. 2007, pp. 1558-1561). In streams and rivers with temperatures approaching or at the upper limit of allowable water temperatures, there is little if any likelihood that bull trout will be able to adapt to or avoid the effects of climate change/warming. There is little doubt that climate change is and will be an important factor affecting bull trout distribution. As its distribution contracts, patch size decreases and connectivity is truncated, bull trout populations that may be currently connected may face increasing isolation, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007, pp. 1559-1560). Due to variations in land form and geographic location across the range of the bull trout, it appears that some populations face higher risks than others. Bull trout in areas with currently degraded water temperatures and/or at the southern edge of its range may already be at risk of adverse impacts from current as well as future climate change.

The ability to assign the effects of gradual global climate change to bull trout or to a specific location on the ground is beyond our technical capabilities at this time.

Conservation

Conservation Needs

The 2015 recovery plan for bull trout established the primary strategy for recovery of bull trout in the coterminous United States: 1) conserve bull trout so that they are geographically widespread across representative habitats and demographically stable1 in six recovery units; 2) effectively manage and ameliorate the primary threats in each of six recovery units at the core area scale such that bull trout are not likely to become endangered in the foreseeable future; 3) build upon the numerous and ongoing conservation actions implemented on behalf of bull trout since their listing in 1999, and improve our understanding of how various threat factors potentially affect the species; 4) use that information to work cooperatively with our partners to design, fund, prioritize, and implement effective conservation actions in those areas that offer the greatest long-term benefit to sustain bull trout and where recovery can be achieved; and 5) apply adaptive management principles to implementing the bull trout recovery program to account for new information (USFWS 2015, p. v.).

Information presented in prior draft recovery plans published in 2002 and 2004 (USFWS 2002a, 2004) have served to identify recovery actions across the range of the species and to provide a framework for implementing numerous recovery actions by our partner agencies, local working groups, and others with an interest in bull trout conservation.

The 2015 recovery plan (USFWS 2015) integrates new information collected since the 1999 listing regarding bull trout life history, distribution, demographics, conservation successes, etc., and integrates and updates previous bull trout recovery planning efforts across the range of the single DPS listed under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The Service has developed a recovery approach that: 1) focuses on the identification of and effective management of known and remaining threat factors to bull trout in each core area; 2) acknowledges that some extant bull trout core area habitats will likely change (and may be lost) over time; and 3) identifies and focuses recovery actions in those areas where success is likely to meet our goal of ensuring the certainty of conservation of genetic diversity, life history features, and broad geographical representation of remaining bull trout populations so that the protections of the Act are no longer necessary (USFWS 2015, p. 45-46).

To implement the recovery strategy, the 2015 recovery plan establishes categories of recovery actions for each of the six Recovery Units (USFWS 2015, p. 50-51):

1. Protect, restore, and maintain suitable habitat conditions for bull trout.
2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.
3. Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
4. Work with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change.

Bull trout recovery is based on a geographical hierarchical approach. Bull trout are listed as a single DPS within the five-state area of the coterminous United States. The single DPS is subdivided into six biologically-based recover units: 1) Coastal Recovery Unit; 2) Klamath Recovery Unit; 3) Mid-Columbia Recovery Unit; 4) Upper Snake Recovery Unit; 5) Columbia Headwaters Recovery Unit; and 6) Saint Mary Recovery Unit (USFWS 2015, p. 23). A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the genetic makeup of the species); resiliency (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to withstand catastrophic events) (USFWS 2015, p. 33).

Each of the six recovery units contain multiple bull trout core areas, 116 total, which are non-overlapping watershed-based polygons, and each core area includes one or more local populations. Currently there are 109 occupied core areas, which comprise 611 local populations (USFWS 2015, p. 3). There are also six core areas where bull trout historically occurred but are now extirpated, and one research needs area where bull trout were known to occur historically, but their current presence and use of the area are uncertain (USFWS 2015, p. 3). Core areas can be further described as complex or simple (USFWS 2015, p. 3-4). Complex core areas contain multiple local bull trout populations, are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat and FMO habitats. Simple core areas are those that contain one bull trout local population. Simple core areas are small in scope, isolated from other core areas by natural barriers, and may contain unique genetic or life history adaptations.

A local population is a group of bull trout that spawn within a particular stream or portion of a stream system (USFWS 2015, p. 73). A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit. For most waters where specific information is lacking, a local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between local populations (e.g., those within a core population), but is assumed to be infrequent compared with that among individuals within a local population.

Recovery Units and Local Populations

The final recovery plan (USFWS 2015) designates six bull trout recovery units as described above. These units replace the 5 interim recovery units previously identified (USFWS 1999). The Service will address the conservation of these final recovery units in our section 7(a)(2) analysis for proposed Federal actions. The recovery plan (USFWS 2015), identified threats and factors affecting the bull trout within these units. A detailed description of recovery implementation for each recovery unit is provided in separate recovery unit implementation plans (RUIPs)(USFWS 2015a-f), which identify conservation actions and recommendations needed for each core area, forage/ migration/ overwinter areas, historical core areas, and research needs areas. Each of the following recovery units (below) is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

Coastal Recovery Unit

The coastal recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015a). The Coastal Recovery Unit is located within western Oregon and Washington. The Coastal Recovery Unit is divided into three regions: Puget Sound, Olympic Peninsula, and the Lower Columbia River Regions. This recovery unit contains 20 core areas comprising 84 local populations and a single potential local population in the historic Clackamas River core area where bull trout had been extirpated and were reintroduced in 2011, and identified four historically occupied core areas that could be re-established (USFWS 2015, pg. 47; USFWS 2015a, p. A-2). Core areas within Puget Sound and the Olympic Peninsula currently support the only anadromous local populations of bull trout. This recovery unit also contains ten shared FMO habitats which are outside core areas and allows for the continued natural population dynamics in which the core areas have evolved (USFWS 2015a, p. A-5). There are four core areas within the Coastal Recovery Unit that have been identified as current population strongholds: Lower Skagit, Upper Skagit, Quinault River, and Lower Deschutes River (USFWS 2015, p.79). These are the most stable and abundant bull trout populations in the recovery unit. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, loss of functioning estuarine and nearshore marine habitats, development and related impacts (e.g., flood control, floodplain disconnection, bank armoring, channel straightening, loss of instream habitat complexity), agriculture (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation, livestock grazing), fish passage (e.g., dams, culverts, instream flows) residential development, urbanization, forest management practices (e.g., timber harvest and associated road building activities), connectivity impairment, mining, and the introduction of non-native species. Conservation measures or recovery actions implemented include relicensing of major hydropower facilities that have provided upstream and downstream fish passage or complete removal of dams, land acquisition to conserve bull trout habitat, floodplain restoration, culvert removal, riparian revegetation, levee setbacks, road removal, and projects to protect and restore important nearshore marine habitats.

Klamath Recovery Unit

The Klamath recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015b). The Klamath Recovery Unit is located in southern Oregon and northwestern California. The Klamath Recovery Unit is the most significantly imperiled recovery unit, having experienced considerable extirpation and geographic contraction of local populations and declining demographic condition, and natural re-colonization is constrained by dispersal barriers and presence of nonnative brook trout (USFWS 2015, p. 39). This recovery unit currently contains three core areas and eight local populations (USFWS 2015, p. 47; USFWS 2015b, p. B-1). Nine historic local populations of bull trout have become extirpated (USFWS 2015b, p. B-1). All three core areas have been isolated from other bull trout populations for the past 10,000 years (USFWS 2015b, p. B-3. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, nonnative species, and past fisheries management practices. Conservation measures or recovery actions implemented include removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culver replacement, and habitat restoration.

Mid-Columbia Recovery Unit

The Mid-Columbia recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015c). The Mid-Columbia Recovery Unit is located within eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia Recovery Unit is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake Geographic Regions. This recovery unit contains 24 occupied core areas comprising 142 local populations, two historically occupied core areas, one research needs area, and seven FMO habitats (USFWS 2015, pg. 47; USFWS 2015c, p. C-1–4). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, agricultural practices (e.g. irrigation, water withdrawals, livestock grazing), fish passage (e.g. dams, culverts), nonnative species, forest management practices, and mining. Conservation measures or recovery actions implemented include road removal, channel restoration, mine reclamation, improved grazing management, removal of fish barriers, and instream flow requirements.

Columbia Headwaters Recovery Unit

The Columbia headwaters recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015d, entire). The Columbia Headwaters Recovery Unit is located in western Montana, northern Idaho, and the northeastern corner of Washington. The Columbia Headwaters Recovery Unit is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene Geographic Regions (USFWS 2015d, pp. D-2 – D-4). This recovery unit contains 35 bull trout core areas; 15 of which are complex core areas as they represent larger interconnected habitats and 20 simple core areas as they are isolated headwater lakes with single local populations. The 20 simple core areas are each represented by a single local population, many of which may have persisted for thousands of years despite small populations and isolated existence (USFWS 2015d, p. D-1). Fish passage improvements within the recovery unit have reconnected some previously fragmented habitats (USFWS 2015d, p. D-1), while others remain fragmented. Unlike the other recovery units in Washington, Idaho and Oregon, the Columbia Headwaters Recovery Unit does not have any anadromous fish overlap. Therefore, bull trout within the Columbia Headwaters Recovery Unit do not benefit from the recovery actions for salmon (USFWS 2015d, p. D-41). The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, mostly historical mining and contamination by heavy metals, expanding populations of nonnative fish predators and competitors, modified instream flows, migratory barriers (e.g., dams), habitat fragmentation, forest practices (e.g., logging, roads), agriculture practices (e.g. irrigation, livestock grazing), and residential development. Conservation measures or recovery actions implemented include habitat improvement, fish passage, and removal of nonnative species.

Upper Snake Recovery Unit

The Upper Snake recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015e, entire). The Upper Snake Recovery Unit is located in central Idaho, northern Nevada, and eastern Oregon. The Upper Snake Recovery Unit is divided into seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. This recovery unit contains 22 core areas and 207 local populations (USFWS 2015, p. 47), with almost 60 percent being present in the Salmon River Region. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, dams, mining, forest management practices, nonnative species, and agriculture (e.g., water diversions, grazing). Conservation measures or recovery actions implemented include instream habitat restoration, instream flow requirements, screening of irrigation diversions, and riparian restoration.

St. Mary Recovery Unit

The St. Mary recovery unit implementation plan describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (USFWS 2015f). The Saint Mary Recovery Unit is located in Montana but is heavily linked to downstream resources in southern Alberta, Canada. Most of the Saskatchewan River watershed which the St. Mary flows into is located in Canada. The United States portion includes headwater spawning and rearing habitat and the upper reaches of FMO habitat. This recovery unit contains four core areas, and seven local populations (USFWS 2015f, p. F-1) in the U.S. Headwaters. The current condition of the bull trout in this recovery unit is attributed primarily to the outdated design and operations of the Saint Mary Diversion operated by the Bureau of Reclamation (e.g., entrainment, fish passage, instream flows), and, to a lesser extent habitat impacts from development and nonnative species.

Tribal Conservation Activities

Many Tribes throughout the range of the bull trout are participating on bull trout conservation working groups or recovery teams in their geographic areas of interest. Some tribes are also implementing projects which focus on bull trout or that address anadromous fish but benefit bull trout (e.g., habitat surveys, passage at dams and diversions, habitat improvement, and movement studies).

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APPENDIX B
STATUS OF BULL TROUT CRITICAL HABITAT

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Appendix B
Status of Bull Trout Critical Habitat

Past designations of critical habitat have used the terms "primary constituent elements" (PCEs), “physical and biological features” (PBFs) or "essential features" to characterize the key components of critical habitat that provide for the conservation of the listed species. The new critical habitat regulations (81 FR 7214) discontinue use of the terms “PCEs” or “essential features” and rely exclusively on use of the term PBFs for that purpose because that term is contained in the statute. To be consistent with that shift in terminology and in recognition that the terms PBFs, PCEs, and essential habit features are synonymous in meaning, we are only referring to PBFs herein. Therefore, if a past critical habitat designation defined essential habitat features or PCEs, they will be referred to as PBFs in this document. This does not change the approach outlined above for conducting the ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs or essential features.

Current Legal Status of the Critical Habitat

Current Designation

The U.S. Fish and Wildlife Service (Service) published a final critical habitat designation for the coterminous United States population of the bull trout on October 18, 2010 (USFWS 2010, entire); the rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on the Service’s website: (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species’ coterminous range, which includes the Coastal, Klamath, Mid-Columbia, Upper Snake, Columbia Headwaters and St. Mary’s Recovery Unit population segments. Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles as bull trout critical habitat (Table 1). Designated bull trout critical habitat is of two primary use types: 1) spawning and rearing, and 2) foraging, migration, and overwintering (FMO).

Table 1. Stream/Shoreline Distance and Reservoir/Lake Area Designated as Bull Trout Critical Habitat.

State	Stream/Shoreline Miles	Stream/Shoreline Kilometers	Reservoir/ Lake Acres	Reservoir/ Lake Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	-	-
Oregon[1]	2,835.9	4,563.9	30,255.5	12,244.0
Oregon/Idaho[2]	107.7	173.3	-	-
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	-	-
Washington/Idaho	37.2	59.9	-	-
Washington/Oregon	301.3	484.8	-	-
Total[3]	19,729.0	31,750.8	488,251.7	197,589.2

[1] No shore line is included in Oregon
[2] Pine Creek Drainage which falls within Oregon
[3] Total of freshwater streams: 18,975

The 2010 revision increases the amount of designated bull trout critical habitat by approximately 76 percent for miles of stream/shoreline and by approximately 71 percent for acres of lakes and reservoirs compared to the 2005 designation.

The final rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower main stem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: 1) waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of this final rule; 2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or 3) waters where impacts to national security have been identified (USFWS 2010, p. 63903). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant Critical Habitat Unit

(CHU) text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

The Physical and Biological Features

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (USFWS 2010, p. 63898). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. CHUs generally encompass one or more core areas and may include FMO areas, outside of core areas, that are important to the survival and recovery of bull trout.

Thirty-two CHUs within the geographical area occupied by the species at the time of listing are designated under the revised rule. Twenty-nine of the CHUs contain all of the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River Basins contain most of the physical or biological features necessary to support the bull trout's particular use of that habitat, other than those physical biological features associated with physical and biological features (PBFs) 5 and 6, which relate to breeding habitat.

The primary function of individual CHUs is to maintain and support core areas, which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995, pp. 314-315; Healey and Prince 1995, p. 182; MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Hard 1995, pp. 321-322; MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

Physical and Biological Features for Bull Trout

Within the designated critical habitat areas, the PBFs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Based on our current knowledge of the life history, biology, and ecology of this species and the characteristics of the habitat necessary to sustain its essential life-history functions, we have determined that the PBFs, as described within USFWS 2010, are essential for the conservation of bull trout. A summary of those PBFs follows.

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.
3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
5. Water temperatures ranging from 2 °C to 15 °C, with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.
6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.
7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

The revised PBF's are similar to those previously in effect under the 2005 designation. The most significant modification is the addition of a ninth PBF to address the presence of nonnative predatory or competitive fish species. Although this PBF applies to both the freshwater and marine environments, currently no non-native fish species are of concern in the marine environment, though this could change in the future.

Note that only PBFs 2, 3, 4, 5, and 8 apply to marine nearshore waters identified as critical habitat. Also, lakes and reservoirs within the CHUs also contain most of the physical or biological features necessary to support bull trout, with the exception of those associated with PBFs 1 and 6. Additionally, all except PBF 6 apply to FMO habitat designated as critical habitat.

Critical habitat includes the stream channels within the designated stream reaches and has a lateral extent as defined by the bankfull elevation on one bank to the bankfull elevation on the opposite bank. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. If bankfull elevation is not evident on either bank, the ordinary high-water line must be used to determine the lateral extent of critical habitat. The lateral extent of designated lakes is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps. The Service assumes in many cases this is the full-pool level of the waterbody. In areas where only one side of the waterbody is designated (where only one side is excluded), the mid-line of the waterbody represents the lateral extent of critical habitat.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high-water (MHHW) line, including the uppermost reach of the saltwater wedge within tidally influenced freshwater heads of estuaries. The MHHW line refers to the average of all the higher high-water heights of the two daily tidal levels. Marine critical habitat extends offshore to the depth of 10 meters (m) (33 ft) relative to the mean low low-water (MLLW) line (zero tidal level or average of all the lower low-water heights of the two daily tidal levels). This area between the MHHW line and minus 10 m MLLW line (the average extent of the photic zone) is considered the habitat most consistently used by bull trout in marine waters based on known use, forage fish availability, and ongoing migration studies and captures geological and ecological processes important to maintaining these habitats. This area contains essential foraging habitat and migration corridors such as estuaries, bays, inlets, shallow subtidal areas, and intertidal flats.

Adjacent shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by no longer serving the intended conservation role for the species or retaining those PBFs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PBFs to such an extent that the conservation value of critical habitat is appreciably reduced (USFWS 2010, pp. 63898:63943; USFWS 2004a, pp. 140-193; USFWS 2004b, pp. 69-114). The Service's evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998, Ch. 4 p. 39). Thus, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (USFWS 2010, pp. 63898:63901, 63944). Therefore, if a proposed action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (USFWS 2010, pp. 63898:63943).

Current Critical Habitat Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (Ratliff and Howell 1992, entire; Schill 1992, p. 40; Thomas 1992, p. 28; Buchanan et al. 1997, p. vii; Rieman et al. 1997, pp. 15-16; Quigley and Arbelbide 1997, pp. 1176-1177). This condition reflects the condition of bull trout habitat. The decline of bull trout is primarily due to habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, past fisheries management practices, impoundments, dams, water diversions, and the introduction of nonnative species (USFWS 1998, pp. 31648-31649; USFWS 1999, p. 17111).

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PBFs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, p. 141; MBTSG 1998, pp. ii - v, 20-45); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, p. 857; Rieman et al. 2006, pp. 73-76); 4) in the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

Effects of Climate Change on Bull Trout Critical Habitat

One objective of the final rule was to identify and protect those habitats that provide resiliency for bull trout use in the face of climate change. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PBFs 1, 2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Additionally, climate change may exacerbate habitat degradation impacts both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes).

Many of the PBFs for bull trout may be affected by the presence of toxics and/or increased water temperatures within the environment. The effects will vary greatly depending on a number of factors which include which toxic substance is present, the amount of temperature increase, the likelihood that critical habitat would be affected (probability), and the severity and intensity of any effects that might occur (magnitude).

The ability to assign the effects of gradual global climate change bull trout critical habitat or to a specific location on the ground is beyond our technical capabilities at this time.

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APPENDIX C
STATUS OF THE SPECIES: MARBLED MURRELET

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Appendix C
Status of the Species for Marbled Murrelet

The marbled murrelet (*Brachyramphus marmoratus*) (murrelet) was listed by the U.S. Fish and Wildlife Service (Service) as a threatened species in Washington, Oregon, and California in 1992. The primary reasons for listing included extensive loss and fragmentation of the older-age forests that serve as nesting habitat for murrelets, and human-induced mortality in the marine environment from gillnets and oil spills (57 FR 45328 [Oct. 1, 1992]). Although some threats such as gillnet mortality and loss of nesting habitat on Federal lands have been reduced since the 1992 listing, the primary threats to species persistence continue (75 FR 3424 [Jan. 21, 2010]).

Life History

The murrelet is a small, fast-flying seabird in the Alcidae family that occurs along the Pacific coast of North America. Murrelets forage for small schooling fish or invertebrates in shallow, nearshore, marine waters and primarily nest in coastal older-aged coniferous forests. The murrelet lifespan is unknown, but is expected to be in the range of 10 to 20 years based on information from similar alcid species (De Santo and Nelson 1995, pp. 36-37). Murrelet nesting is asynchronous and spread over a prolonged season. In Washington, the murrelet breeding season extends from April 1 to September 23. Egg laying and incubation occur from April to early August and chick rearing occurs between late May and September, with all chicks fledging by late September (Hamer et al. 2003; USFWS 2012a).

Murrelets lay a single-egg which may be replaced if egg failure occurs early in the nesting cycle, but this is rare (Nelson 1997, p. 17). During incubation, one adult sits on the nest while the other forages at sea. Adults typically incubate for a 24-hour period, then exchange duties with their mate at dawn. Chicks hatch between May and August after 30 days of incubation. Hatchlings appear to be brooded by an adult for several days (Nelson 1997, p. 18). Once the chick attains thermoregulatory independence, both adults leave the chick alone at the nest for the remainder of the rearing period, except during feedings. Both parents feed the chick, which receives one to eight meals per day (Nelson 1997, p. 18). Most meals are delivered early in the morning while about a third of the food deliveries occur at dusk and intermittently throughout the day (Nelson and Hamer 1995, p. 62).

Murrelets and other fish-eating alcids exhibit wide variations in nestling growth rates. The nestling stage of murrelet development can vary from 27 to 40 days before fledging (De Santo and Nelson 1995, p. 45). The variations in alcid chick development are attributed to constraints on feeding ecology, such as unpredictable and patchy food distributions, and great distances between feeding and nesting sites (Øyan and Anker-Nilssen 1996, p. 830). Food limitation during nesting often results in poor growth, delayed fledging, increased mortality of chicks, and nest abandonment by adults (Øyan and Anker-Nilssen 1996, p. 836).

Murrelets are believed to be sexually mature at 2 to 4 years of age (Nelson 1997, p. 19). Adult birds may not nest every year, especially when food resources are limited. Recent monitoring efforts in Washington indicated that only 20 percent of monitored murrelet nesting attempts were successful, and only a small portion of the 158 tagged adult birds actually attempted to nest (13 percent) (Raphael and Bloxton 2009, p. 165). The low number of adults attempting to nest is not unique to Washington. Some researchers suspect that the portion of non-breeding adults in murrelet populations can range from about 5 percent to 70 percent depending on the year, but most population modeling studies suggest a range of 5 to 20 percent (McShane et al. 2004, p. 3-5).

<u>Murrelets in the Marine Environment</u>

Marbled murrelets spend most (>90 percent) of their time at sea. Their preferred marine habitat includes sheltered, nearshore waters within 3 miles of shore, although they occur farther offshore in areas of Alaska and during the nonbreeding season (Huff et al. 2006, p. 19). They generally forage in pairs on the water, but they also forage solitarily or in small groups.

Breeding Season

The murrelet is widely distributed in nearshore waters along the west coast of North America. It occurs primarily within 5 km of shore (Alaska, within 50 km), and primarily in protected waters, although its distribution varies with coastline topography, river plumes, riptides, and other physical features (Nelson 1997, p. 3). Murrelet marine distribution is strongly associated with the amount and configuration of terrestrial nesting habitat (Raphael et al. 2015c, p. 17). In other words, they tend to be distributed in marine waters adjacent to areas of suitable breeding habitat. Non-breeding adults and subadults are thought to occur in similar areas as breeding adults. This species does occur farther offshore, but in much reduced numbers (Strachan et al. 1995, p. 247). Their offshore occurrence is probably related to current upwelling and plumes during certain times of the year that tend to concentrate their prey species.

Winter Range

The winter range of the murrelet is poorly documented, but they are present near breeding sites year-round in most areas (Nelson 1997, p. 3). Murrelets exhibit seasonal redistributions during non-breeding seasons. Generally more dispersed and found farther offshore in winter in some areas, although highest concentrations still occur close to shore and in protected waters (Nelson 1997, p. 3). In some areas, murrelets move from the outer exposed coasts of of Vancouver Island and the Straits of Juan de Fuca into the sheltered and productive waters of northern and eastern Puget Sound. Less is known about seasonal movements along the outer coasts of Washington, Oregon, and California (Ralph et al. 1995, p. 9). The farthest offshore records of murrelet distribution are 60 km off the coast of northern California in October, 46 km off the coast of Oregon in February (Adams et al. 2014) and at least 300 km off the coast in Alaska (Piatt and Naslund 1995, p. 287). Known areas of winter concentration include and southern and eastern end of Strait of Juan de Fuca (primarily Sequim, Discovery, and Chuckanut Bays), San Juan Islands and Puget Sound, WA (Speich and Wahl 1995, p. 314).

Foraging and Diet

Murrelets dive and swim through the water by using their wings in pursuit of their prey; their foraging and diving behavior is restricted by physiology. They usually feed in shallow, nearshore water <30 m (98 ft) deep, which seems to provide them with optimal foraging conditions for their generalized diet of small schooling fish and large, pelagic invertebrates: Pacific sand lance (*Ammodytes hexapterus*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea harengus*), surf smelt (*Hypomesus* sp.), euphausiids, mysids, amphipods, and other species (Nelson 1997, p. 7). However, they are assumed to be capable of diving to a depth of 47 m (157 ft) based on their body size and diving depths observed for other Alcid species (Mathews and Burger 1998, p. 71).

Contemporary studies of murrelet diets in the Puget Sound–Georgia Basin region indicate that Pacific sand lance now comprise the majority of the murrelet diet (Gutowsky et al. 2009, p. 251). Historically, energy-rich fishes such as herring and northern anchovy comprised the majority of the murrelet diet (Becker and Beissinger 2006, p. 470; Gutowsky et al. 2009, p. 247). This is significant because sandlance have the lowest energetic value of the fishes that murrelets commonly consume. For example, a single northern anchovy has nearly six times the energetic value of a sandlance of the same size (Gutowsky et al. 2009, p. 251), so a murrelet would have to eat six sandlance to get the equivalent energy of a single anchovy. Reductions in the abundance of energy-rich forage fish species is likely a contributing factor in the poor reproduction in murrelets (Becker and Beissinger 2006, p. 470).

The duration of dives appears to depend upon age (adults vs. juveniles), water depth, visibility, and depth and availability of prey. Dive duration has been observed ranging from 8 seconds to 115 seconds, although most dives are between 25 to 45 seconds (Day and Nigro 2000; Jodice and Collopy 1999; Thoresen 1989; Watanuki and Burger 1999). Diving bouts last over a period of 27 to 33 minutes (Nelson 1997, p. 9). They forage in deeper waters when upwelling, tidal rips, and daily activity of prey concentrate prey near the surface (Strachan et al. 1995). Murrelets are highly mobile and some make substantial changes in their foraging sites within the breeding season. For example, Becker and Beissinger (2003, p. 243) found that murrelets responded rapidly (within days or weeks) to small-scale variability in upwelling intensity and prey availability by shifting their foraging behavior and habitat selection within a 100-km (62-mile) area.

For more information on murrelet use of marine habitats, see literature reviews in McShane et al. 2004 and USFWS 2009.

Murrelets in the Terrestrial Environment

Murrelets are dependent upon older-age forests, or forests with an older tree component, for nesting habitat (Hamer and Nelson 1995, p. 69). Specifically, murrelets prefer high and broad platforms for landing and take-off, and surfaces which will support a nest cup (Hamer and Nelson 1995, pp. 78-79). In Washington, murrelet nests have been found in live conifers, specifically, western hemlock (*Tsuga heterophylla*), Sitka spruce (*Picea sitchensis*), Douglas-fir (*Pseudotsuga menziesii*), and western red cedar (*Thuja plicata*) (Hamer and Nelson 1995; Hamer and Meekins 1999). Most murrelets appear to nest within 37 miles of the coast, although occupied behaviors have been recorded up to 52 miles inland, and murrelet presence has been detected up to 70 miles inland in Washington (Huff et al. 2006, p. 10). Nests occur primarily in large, older-aged trees. Overall, nests have been found in trees greater than 19 inches in diameter-at-breast and greater than 98 ft tall. Nesting platforms include limbs or other branch deformities that are greater than 4 inches in diameter, and are at greater than 33 ft above the ground. Substrate such as moss or needles on the nest platform is important for protecting the egg and preventing it from falling off (Huff et al. 2006, p. 13).

Murrelets do not form dense colonies which is atypical of most seabirds. Limited evidence suggests they may form loose colonies in some cases (Ralph et al. 1995). The reliance of murrelets on cryptic coloration to avoid detection suggests they utilize a wide spacing of nests in order to prevent predators from forming a search image (Ralph et al. 1995). Individual murrelets are suspected to have fidelity to nest sites or nesting areas, although this is has only been confirmed with marked birds in a few cases (Huff et al. 2006, p. 11). There are at least 15 records of murrelets using nest sites in the same or adjacent trees in successive years, but it is not clear if they were used by the same birds (McShane et al. 2004, p. 2-14). At the landscape scale, murrelets do show fidelity to foraging areas and probably to specific watersheds for nesting (McShane et al. 2004, p. 2-14). Murrelets have been observed visiting nesting habitat during non-breeding periods in Washington, Oregon, and California which may indicate adults are maintaining fidelity and familiarity with nesting sites and/or stands (Naslund 1993; O'Donnell et al. 1995, p. 125).

Loss of nesting habitat reduces nest site availability and displaces any murrelets that may have had nesting fidelity to the logged area (Raphael et al. 2002, p. 232). Murrelets have demonstrated fidelity to nesting stands and in some areas, fidelity to individual nest trees (Burger et al. 2009, p. 217). Murrelets returning to recently logged areas may not breed for several years or until they have found suitable nesting habitat elsewhere (Raphael et al. 2002, p. 232). The potential effects of displacement due to habitat loss include nest site abandonment, delayed breeding, failure to initiate breeding in subsequent years, and failed breeding due to increased predation risk at a marginal nesting location (Divoky and Horton 1995, p. 83; Raphael et al. 2002, p. 232). Each of these outcomes has the potential to reduce the nesting success for individual breeding pairs, and could ultimately result in the reduced recruitment of juvenile birds into the local population (Raphael et al. 2002, pp. 231-233).

Detailed information regarding the life history and conservation needs of the murrelet are presented in the *Ecology and Conservation of the Marbled Murrelet* (Ralph et al. 1995), the Service's 1997 *Recovery Plan for the Marbled Murrelet* (USFWS 1997), and in subsequent 5-year status reviews (McShane et al. 2004; USFWS 2009).

Distribution

Murrelets are distributed along the Pacific coast of North America, with birds breeding from central California through Oregon, Washington, British Columbia, southern Alaska, westward through the Aleutian Island chain, with presumed breeding as far north as Bristol Bay (Nelson 1997, p. 2). The federally-listed murrelet population in Washington, Oregon, and California is classified by the Service as a distinct population segment (75 FR 3424). The coterminous United States population of murrelets is considered significant as the loss of this distinct population segment would result in a significant gap in the range of the taxon and the loss of unique genetic characteristics that are significant to the taxon (75 FR 3430).

Murrelets spend most of their lives in the marine environment where they consume a diversity of prey species, including small fish and invertebrates. Murrelets occur primarily in nearshore marine waters within 5 km of the coast, but have been documented up to 300 km offshore in winter off the coast of Alaska (Nelson 1997, p. 3). The inland nesting distribution of murrelets is strongly associated with the presence of mature and old-growth conifer forests. Murrelets have been detected >100 km inland in Washington (70 miles), while the inland distribution in the southern portion of the species range is associated with the extent of the hemlock/tanoak vegetation zone which occurs up to 16-51 km inland (10-32 miles) (Evans Mack et al. 2003, p. 4).

The distribution of murrelets in marine waters during the summer breeding season is highly variable along the Pacific coast, with areas of high density occurring along the Strait of Juan de Fuca in Washington, the central Oregon coast, and northern California (Raphael et al. 2015c, p. 20). Low-density areas or gaps in murrelet distribution occur in central California, and along the southern Washington coast (Raphael et al. 2015c, p. 21). Analysis of various marine and terrestrial habitat factors indicate that the amount and configuration of inland nesting habitat is the strongest factor that influences the marine distribution of murrelets during the nesting season (Raphael et al. 2015c, p. 17). Local aggregations or "hot spots" of murrelets in nearshore marine waters are strongly associated with landscapes that support large, contiguous areas of mature and old-growth forest.

Distribution of Nesting Habitat

The loss of nesting habitat was a major cause of the murrelets decline over the past century and may still be contributing as nesting habitat continues to be lost to fires, logging, and wind storms (Miller et al. 2012, p. 778). Due mostly to historic timber harvest, only a small percentage (~11 percent) of the habitat-capable lands within the listed range of the murrelet currently contain potential nesting habitat (Raphael et al. 2015b, p. 118). Monitoring of murrelet nesting habitat within the Northwest Forest Plan area indicates nesting habitat declined from an estimated 2.53 million acres in 1993 to an estimated 2.23 million acres in 2012, a decline of about 12.1 percent (Raphael et al. 2015b, p. 89). Fire has been the major cause of nesting habitat loss on Federal lands, while timber harvest is the primary cause of loss on non-Federal lands (Raphael et al. 2015b, p. 90). While most (60 percent) of the potential habitat is located on Federal reserved-land allocations, a substantial amount of nesting habitat occurs on non-federal lands (34 percent) (Table 1).

Table 1. Estimates of higher-quality murrelet nesting habitat by State and major land ownership within the area of the Northwest Forest Plan – derived from 2012 data.

State	Habitat capable lands (1,000s of acres)	Habitat on Federal reserved lands (1,000s of acres)	Habitat on Federal non-reserved lands (1,000s of acres)	Habitat on non-federal lands (1,000s of acres)	Total potential nesting habitat (all lands) (1,000s of acres)	Percent of habitat capable land that is currently in habitat
WA	10,851.1	822.4	64.7	456	1,343.1	12 %
OR	6,610.4	484.5	69.2	221.1	774.8	12 %
CA	3,250.1	24.5	1.5	82.9	108.9	3 %
Totals	20,711.6	1,331.4	135.4	760	2,226.8	11 %
Percent		60 %	6 %	34 %	100 %	-

Source: (Raphael et al. 2015b, pp. 115-118)

Population Status

The 1997 *Recovery Plan for the Marbled Murrelet* (USFWS 1997) identified six Conservation Zones throughout the listed range of the species: Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation Zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6) (Figure 1). Recovery zones are the functional equivalent of recovery units as defined by Service policy (USFWS 1997, p. 115). The subpopulations in each Zone are not discrete. There is some movement of murrelets between Zones as indicated by radio-telemetry studies (e.g., Bloxton and Raphael 2006, p. 162), but the degree to which murrelets migrate between Zones is unknown. For the purposes of consultation, the Service treats each of the Conservation Zones as separate sub-populations of the listed murrelet population.

Population Status and Trends

Population estimates for the murrelet are derived from marine surveys conducted during the nesting season as part of the Northwest Forest Plan effectiveness monitoring program. Surveys from 2001 to 2013 indicated that the murrelet population in Conservation Zones 1 through 5 (Northwest Forest Plan area) declined at a rate of -1.2 percent per year (Falxa et al. 2015, pp. 7-8). While the overall trend estimate across this time period is negative, the evidence of a detectable linear decline is not conclusive because the confidence intervals for the estimated trend overlap zero (95% confidence interval [CI]:-2.9 to 0.5 percent) (Falxa et al. 2015, pp. 7-8) (Table 2). This differs from the declines previously reported at the Northwest Forest Plan-scale for the 2001 to 2010 period. This difference was the result of high population estimates for 2011 through 2013 compared to the previous several years, which reduced the slope of the trend and increased variability (Falxa and Raphael 2015, p. 4).

Population monitoring from 2001 to 2013 indicates strong evidence for a linear decline for murrelet subpopulations in Washington, while trends in Oregon and northern California indicate potentially stable or increasing subpopulations with no conclusive evidence of a positive or negative trend over the monitoring period (Falxa et al. 2015, p. 26). While the direct causes for subpopulation declines in Washington are unknown, potential factors include the loss of nesting habitat, including cumulative and time-lag effects of habitat losses over the past 20 years (an individual murrelets potential lifespan), changes in the marine environment reducing the availability or quality of prey, increased densities of nest predators, and emigration (Miller et al. 2012, p. 778).

The most recent population estimate for the entire Northwest Forest Plan area in 2013 was 19,700 murrelets (95 percent CI: 15,400 to 23,900 birds) (Falxa et al. 2015, p. 7). The largest and most stable murrelet subpopulations now occur off the Oregon and northern California coasts, while subpopulations in Washington have experienced the greatest rates of decline. Murrelet zones are now surveyed on an every other-year basis, so the last year that a range-wide estimate for all zones combined is 2013 (Table 2). Subsequent surveys in Washington, Oregon, and California have been completed during the 2014 and 2015 seasons. Summaries of these more recent surveys are presented in Table 3.

The murrelet subpopulation in Conservation Zone 6 (central California- Santa Cruz Mountains) is outside of the Northwest Forest Plan area and is monitored separately by the University of California as part of an oil-spill compensation program (Henry et al. 2012, p. 2). Surveys in Zone 6 indicate a small subpopulation of murrelets with no clear trends. Population estimates from 2001 to 2014 have fluctuated from a high of 699 murrelets in 2003, to a low of 174 murrelets in 2008 (Henry and Tyler 2014, p. 3). In 2014, surveys indicated an estimated population of 437 murrelets in Zone 6 (95% CI: 306-622) (Henry and Tyler 2014, p. 3) (Table 3).

Table 2. Summary of murrelet population estimates and trends (2001-2013) at the scale of Conservation Zones and States (estimates combined across Zones within the Northwest Forest Plan area).

Zone	Year	Estimated number of murrelets	95% CI Lower	95% CI Upper	Average density (at sea) (murrelets /km^2)	Average annual rate of change (%)	95% CI Lower	95% CI Upper	Cumulative change over 10 years (%)
1	2013	4,395	2,298	6,954	1.26	-3.9	-7.6	0.0	-32.8
2	2013	1,271	950	1,858	0.77	-6.7	-11.4	-1.8	-50.0
3	2013	8,841	6,819	11,276	5.54	+1.3	-1.1	+3.8	+6.2
4	2013	6,046	4,531	9,282	5.22	+1.5	-0.9	+4.0	+16.1
5	2013	71	5	118	0.08	-1.0	-8.3	+6.9	-9.6
Zones 1-5	2013	19,662	15,398	23,927	2.24	-1.2	-2.9	+0.5	-11.3
Zone 6	2013	628	386	1,022	na	na	na	na	na
WA	2013	5,665	3,217	8,114	1.10	-5.1	-7.7	-2.5	-37.6
OR	2013	9,819	6,158	13,480	4.74	0.3	-1.8	2.5	+3.0
CA	2013	4,178	3,561	4,795	2.67	2.5	-1.1	6.2	+28.0

Sources: (Falxa et al. 2015, pp. 41-43; Henry and Tyler 2014, p. 3).

Table 3. Summary of the most recent murrelet population estimates by Zone (2014-2015).

Zone	Year	Estimated number of murrelets	Estimated population 95% CI Lower	Estimated population 95% CI Upper	Average annual rate of decline (2001-2015)
1	2015	4,290	2,783	6,492	-5.3 %
2	2015	3,204	1,883	5,609	-2.8 %
3	2014	8,841	6,819	11,276	nc
4	2015	8,743	7,409	13,125	nc
5	2013	71	5	118	nc
6	2014	437	306	622	nc

Sources: (Henry and Tyler 2014, p. 3; Lance and Pearson 2016, pp. 4-5; NWFPEMP 2016, pp. 2-3).

Factors Influencing Population Trends

Murrelet populations are declining in Washington, stable in Oregon, and stable in California where there is a non-significant but positive population trend (Raphael et al. 2015a, p. 163). Murrelet population size and distribution is strongly and positively correlated with the amount and pattern (large contiguous patches) of suitable nesting habitat and population trend is most strongly correlated with trend in nesting habitat although marine factors also contribute to this trend (Raphael et al. 2015a, p. 156). From 1993 to 2012, there was a net loss of about 2 percent of potential nesting habitat from on federal lands, compared to a net loss of about 27 percent on nonfederal lands, for a total cumulative net loss of about 12.1 percent across the Northwest Forest Plan area (Raphael et al. 2015b, p. 66). Cumulative habitat losses since 1993 have been greatest in Washington, with most habitat loss in Washington occurring on non-Federal lands due to timber harvest (Raphael et al. 2015b, p. 124) (Table 4).

Table 4. Distribution of higher-suitability murrelet nesting habitat by Conservation Zone, and summary of net habitat changes from 1993 to 2012 within the Northwest Forest Plan area.

Conservation Zone	**1993**	**2012**	**Change (acres)**	**Change (percent)**
Zone 1 - Puget Sound/Strait of Juan de Fuca	829,525	739,407	-90,118	-10.9 %
Zone 2 - Washington Coast	719,414	603,777	-115,638	-16.1 %
Zone 3 - Northern to central Oregon	662,767	610,583	-52,184	-7.9 %
Zone 4 - Southern Oregon - northern California	309,072	256,636	-52,436	-17 %
Zone 5 - north-central California	14,060	16,479	+2,419	+17.2 %

Source: (Raphael et al. 2015b, p. 121).

The decline in murrelet populations from 2001 to 2013 is weakly correlated with the decline in nesting habitat, with the greatest declines in Washington, and the smallest declines in California, indicating that when nesting habitat decreases, murrelet abundance in adjacent marine waters may also decrease. At the scale of Conservation Zones, the strongest correlation between habitat loss and murrelet decline is in Zone 2, the zone where both murrelet habitat and murrelet abundance has declined the greatest. However these relationships are not linear, and there is much unexplained variation (Raphael et al. 2015a, p. 163). While terrestrial habitat amount and configuration (i.e., fragmentation) and the terrestrial human footprint (i.e., cities, roads, development) appear to be strong factors influencing murrelet distribution in Zones 2-5; terrestrial habitat and the marine human footprint (i.e., shipping lanes, boat traffic, shoreline development) appear to be the most important factors that influence the marine distribution and abundance of murrelets in Zone 1 (Raphael et al. 2015a, p. 163).

As a marine bird, murrelet survival is dependent on their ability to successfully forage in the marine environment. Despite this, it is apparent that the location, amount, and landscape pattern of terrestrial nesting habitat are strongest predictors of the spatial and temporal distributions of murrelets at sea during the nesting season (Raphael et al. 2015c, p. 20). Various marine habitat features (e.g., shoreline type, depth, temperature, etc.) apparently have only a minor influence on murrelet distribution at sea. Despite this relatively weak spatial relationship, marine factors, and especially any decrease in forage species, likely play an important role in explaining the apparent population declines, but the ability to model these relationships is currently limited (Raphael et al. 2015c, p. 20).

Population Models

Prior to the use of survey data to estimate trend, demographic models were more heavily relied upon to generate predictions of trends and extinction probabilities for the murrelet population (Beissinger 1995; Cam et al. 2003; McShane et al. 2004; USFWS 1997). However, murrelet population models remain useful because they provide insights into the demographic parameters and environmental factors that govern population stability and future extinction risk, including stochastic factors that may alter survival, reproductive, and immigration/emigration rates.

In a report developed for the *5-year Status Review of the Marbled Murrelet in Washington, Oregon, and California* (McShane et al. 2004, p. 3-27 to 3-60), models were used to forecast 40-year murrelet population trends. A series of female-only, multi-aged, discrete-time stochastic Leslie Matrix population models were developed for each conservation zone to forecast decadal population trends over a 40-year period with extinction probabilities beyond 40 years (to 2100). The authors incorporated available demographic parameters (Table 5) for each conservation zone to describe population trends and evaluate extinction probabilities (McShane et al. 2004, p. 3-49).

McShane et al. (2004) used mark-recapture studies conducted in British Columbia by Cam et al. (2003) and Bradley et al. (2004) to estimate annual adult survival and telemetry studies or at-sea survey data to estimate fecundity. Model outputs predicted -3.1 to -4.6 percent mean annual rates of population change (decline) per decade the first 20 years of model simulations in murrelet Conservation Zones 1 through 5 (McShane et al. 2004, p. 3-52). Simulations for all zone populations predicted declines during the 20 to 40-year forecast, with mean annual rates of -2.1 to -6.2 percent per decade (McShane et al. 2004, p. 3-52). While these modeled rates of decline are similar to those observed in Washington (Falxa and Raphael 2015, p. 4), the simulated projections at the scale of Zones 1-5 do not match the potentially stable or increasing populations observed in Oregon and California during the 2001-2013 monitoring period.

Table 5. Rangewide murrelet demographic parameter values based on four studies all using Leslie Matrix models.

Demographic Parameter	Beissinger 1995	Beissinger and Nur 1997*	Beissinger and Peery (2007)	McShane et al. 2004
Juvenile Ratio (Ŕ)	0.10367	0.124 or 0.131	0.089	0.02 - 0.09
Annual Fecundity	0.11848	0.124 or 0.131	0.06-0.12	-
Nest Success	-	-	0.16-0.43	0.38 - 0.54
Maturation	3	3	3	2 - 5
Estimated Adult Survivorship	85 % – 90%	85 % – 88 %	82 % - 90 %	83 % – 92 %

*In U.S. Fish and Wildlife (1997).

Reproduction

Generally, estimates of murrelet fecundity are directed at measures of breeding success, either from direct assessments of nest success in the terrestrial environment, marine counts of hatch-year birds, or computer models. Telemetry estimates are typically preferred over marine counts for estimating breeding success due to fewer biases (McShane et al. 2004, p. 3-2). However, because of the challenges of conducting telemetry studies, estimating murrelet reproductive rates with an index of reproduction, referred to as the juvenile ratio (Ŕ),[1] continues to be important, despite the debate over use of this index (see discussion in Beissinger and Peery 2007, p. 296).

Although difficult to obtain, nest success rates[2] are available from telemetry studies conducted in California (Hebert and Golightly 2006; Peery et al. 2004) and Washington (Bloxton and Raphael 2006). In northwest Washington, Bloxton and Raphael (2005, p. 5) documented a nest success rate of 0.20 (2 chicks fledging from 10 nest starts). In central California, murrelet nest success is 0.16 (Peery et al. 2004, p. 1098) and in northern California it is 0.31 to 0.56 (Hebert and Golightly 2006, p. 95). No studies or published reports from Oregon are available.

Unadjusted and adjusted values for estimates of murrelet juvenile ratios suggest extremely low breeding success in northern California (0.003 to 0.008 - Long et al. 2008, pp. 18-19), central California (0.035 and 0.032 - Beissinger and Peery 2007, pp. 299, 302), and in Oregon (0.0254 - 0.0598 - Crescent Coastal Research 2008, p. 13). Estimates for **Ŕ** (adjusted) in the San Juan Islands in Washington have been below 0.15 every year since surveys began in 1995, with three of those years below 0.05 (Raphael et al. 2007, p. 16).

[1] The juvenile ratio (**Ŕ**) for murrelets is derived from the relative abundance of hatch-year (HY; 0-1 yr-old) to after-hatch-year (AHY; 1+ yr-old) birds (Beissinger and Peery 2007, p. 297) and is calculated from marine survey data.
[2] Nest success here is defined by the annual number of known hatchlings departing from the nest (fledging) divided by the number of nest starts.

These estimates of **Ŕ** are assumed to be below the level necessary to maintain or increase the murrelet population. Demographic modeling suggests murrelet population stability requires a minimum reproductive rate of 0.18 to 0.28 (95 % CI) chicks per pair per year (Beissinger and Peery 2007, p. 302; USFWS 1997). Even the lower levels of the 95 percent confidence interval from USFWS (1997) and Beissinger and Peery (2007, p. 302) is greater than the current range of estimates for Ŕ (0.02 to 0.13 chicks per pair) for any of the Conservation Zones (Table 4).

The current estimates for **Ŕ** also appear to be well below what may have occurred prior to the murrelet population decline. Beissinger and Peery (2007, p. 298) performed a comparative analysis using historic data from 29 bird species to predict the historic **Ŕ** for murrelets in central California, resulting in an estimate of 0.27 (95% CI: 0.15 - 0.65). Therefore, the best available scientific information of murrelet fecundity from model predictions and trend analyses of survey-derived population data appear to align well. Both indicate that the murrelet reproductive rate is generally insufficient to maintain stable population numbers throughout all or portions of the species' listed range.

<u>Summary: Murrelet Abundance, Distribution, Trend, and Reproduction</u>

Although murrelets are distributed throughout their historical range, the area of occupancy within their historic range appears to be reduced from historic levels. The distribution of the species also exhibits five areas of discontinuity: a segment of the border region between British Columbia, Canada and Washington; southern Puget Sound, WA; Destruction Island, WA to Tillamook Head, OR; Humboldt County, CA to Half Moon Bay, CA; and the entire southern end of the breeding range in the vicinity of Santa Cruz and Monterey Counties, CA (McShane et al. 2004, p. 3-70).

A statistically significant decline was detected in Conservation Zones 1 and 2 for the 2001-2014 period (Table 2). The overall population trend from the combined 2001-2013 population estimates (Conservation Zones 1 - 5) indicate a decline at a rate of -1.2 percent per year (Falxa et al. 2015, pp. 7-8). This decline across the listed range is most influenced by the significant declines in Washington, while subpopulations in Oregon and California are potentially stable.

The current range of estimates for **Ŕ**, the juvenile to adult ratio, is assumed to be below the level necessary to maintain or increase the murrelet population. Whether derived from marine surveys or from population modeling (**Ŕ** = 0.02 to 0.13, Table 4), the available information is in general agreement that the current ratio of hatch-year birds to after-hatch year birds is insufficient to maintain stable numbers of murrelets throughout the listed range. The current estimates for **Ŕ** also appear to be well below what may have occurred prior to the murrelet population decline (Beissinger and Peery 2007, p. 298).

Considering the best available data on abundance, distribution, population trend, and the low reproductive success of the species, the Service concludes the murrelet population within the Washington portion of its listed range currently has little or no capability to self-regulate, as indicated by the significant, annual decline in abundance the species is currently undergoing in Conservation Zones 1 and 2. Populations in Oregon and California are apparently more stable, but threats associated with habitat loss and habitat fragmentation continue to occur in those areas. The Service expects the species to continue to exhibit further reductions in the distribution and abundance into the foreseeable future, due largely to the expectation that the variety of environmental stressors present in the marine and terrestrial environments (discussed in the *Threats to Murrelet Survival and Recovery* section) will continue into the foreseeable future.

Threats to Murrelet Survival and Recovery

When the murrelet was listed under the Endangered Species Act in 1992, several anthropogenic threats were identified as having caused the dramatic decline in the species:

- habitat destruction and modification in the terrestrial environment from timber harvest and human development caused a severe reduction in the amount of nesting habitat
- unnaturally high levels of predation resulting from forest "edge effects" ;
- the existing regulatory mechanisms, such as land management plans (in 1992), were considered inadequate to ensure protection of the remaining nesting habitat and reestablishment of future nesting habitat; and
- manmade factors such as mortality from oil spills and entanglement in fishing nets used in gill-net fisheries.

The regulatory mechanisms implemented since 1992 that affect land management in Washington, Oregon, and California (for example, the Northwest Forest Plan) and new gill-netting regulations in northern California and Washington have reduced the threats to murrelets (USFWS 2004, pp. 11-12). However, additional threats were identified in the Service's 2009, 5-year review for the murrelet (USFWS 2009, pp. 27-67). These stressors are due to several environmental factors affecting murrelets in the marine environment. These stressors include:

- Habitat destruction, modification, or curtailment of the marine environmental conditions necessary to support murrelets due to:
    - elevated levels of polychlorinated biphenyls in murrelet prey species;
    - changes in prey abundance and availability;
    - changes in prey quality;
    - harmful algal blooms that produce biotoxins leading to domoic acid and paralytic shellfish poisoning that have caused murrelet mortality; and
    - climate change in the Pacific Northwest.

- Manmade factors that affect the continued existence of the species include:
    - derelict fishing gear leading to mortality from entanglement;
    - disturbance in the marine environment (from exposures to lethal and sub-lethal levels of high underwater sound pressures caused by pile-driving, underwater detonations, and potential disturbance from high vessel traffic).

Since the time of listing, the murrelet population has continued to decline due to lack of successful reproduction and recruitment. The murrelet Recovery Implementation Team identified five major mechanisms that appear to be contributing to this decline (USFWS 2012b, pp. 10-11):

- Ongoing and historic loss of nesting habitat.
- Predation on murrelet eggs and chicks in their nests.
- Changes in marine conditions, affecting the abundance, distribution, and quality of murrelet prey species.
- Post-fledging mortality (predation, gill-nets, oil-spills).
- Cumulative and interactive effects of factors on individuals and populations.

Climate Change

In the Pacific Northwest, mean annual temperatures rose 0.8° C (1.5° F) in the 20th century and are expected to continue to warm from 0.1° to 0.6° C (0.2° to 1° F) per decade (Mote and Salathe 2010, p. 29). Climate change models generally predict warmer, wetter winters and hotter, drier summers and increased frequency of extreme weather events in the Pacific Northwest (Salathé et al. 2010, pp. 72-73). Predicted climate changes in the Pacific Northwest have implications for forest disturbances that affect the quality and distribution of murrelet habitat. Both the frequency and intensity of wildfires and insect outbreaks are expected to increase over the next century in the Pacific Northwest (Littell et al. 2010, p. 130).

One of the largest projected effects on Pacific Northwest forests is likely to come from an increase in fire frequency, duration, and severity. Westerling et al. (2006, pp. 940-941) analyzed wildfires and found that since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period from 1970-1986. The total area burned is more than 6.5 times the previous level and the average length of the fire season during 1987-2003 was 78 days longer compared to 1978-1986 (Westerling et al. 2006, p. 941). The area burned annually by wildfires in the Pacific Northwest is expected to double or triple by the 2080s (Littell et al. 2010, p. 140). Wildfires are now the primary cause of murrelet habitat loss on Federal lands, with over 21,000 acres of habitat loss attributed to wildfires from 1993 to 2012 (Raphael et al. 2015b, p. 123). Climate change is likely to further exacerbate some existing threats such as the projected potential for increased habitat loss from drought related fire, mortality, insects and disease, and increases in extreme flooding, landslides and windthrow events in the short-term (10 to 30 years).

Within the marine environment, effects on the murrelet food supply (amount, distribution, quality) provide the most likely mechanism for climate change impacts to murrelets. Studies in British Columbia (Norris et al. 2007) and California (Becker and Beissinger 2006) have documented long-term declines in the quality of murrelet prey, and one of these studies (Becker and Beissinger 2006, p. 475) linked variation in coastal water temperatures, murrelet prey quality during pre-breeding, and murrelet reproductive success. These studies indicate that murrelet recovery may be affected as long-term trends in ocean climate conditions affect prey resources and murrelet reproductive rates. While seabirds such as the murrelet have life-history strategies adapted to variable marine environments, ongoing and future climate change could present changes of a rapidity and scope outside the adaptive range of murrelets (USFWS 2009, p. 46).

Conservation Needs of the Species

Reestablishing an abundant supply of high quality murrelet nesting habitat is a vital conservation need given the extensive removal during the 20th century. However, there are other conservation imperatives. Foremost among the conservation needs are those in the marine and terrestrial environments to increase murrelet fecundity by increasing the number of breeding adults, improving murrelet nest success (due to low nestling survival and low fledging rates), and reducing anthropogenic stressors that reduce individual fitness or lead to mortality.

The overall reproductive success (fecundity) of murrelets is directly influenced by nest predation rates (reducing nestling survival rates) in the terrestrial environment and an abundant supply of high quality prey in the marine environment during the breeding season (improving potential nestling survival and fledging rates). Anthropogenic stressors affecting murrelet fitness and survival in the marine environment are associated with commercial and tribal gillnets, derelict fishing gear, oil spills, and high underwater sound pressure (energy) levels generated by pile-driving and underwater detonations (that can be lethal or reduce individual fitness).

General criteria for murrelet recovery (delisting) were established at the inception of the Plan and they have not been met. More specific delisting criteria are expected in the future to address population, demographic, and habitat based recovery criteria (USFWS 1997, p. 114-115). The general criteria include:

- documenting stable or increasing population trends in population size, density, and productivity in four of the six Conservation Zones for a 10-year period and
- implementing management and monitoring strategies in the marine and terrestrial environments to ensure protection of murrelets for at least 50 years.

Thus, increasing murrelet reproductive success and reducing the frequency, magnitude, or duration of any anthropogenic stressor that directly or indirectly affects murrelet fitness or survival in the marine and terrestrial environments are the priority conservation needs of the species. The Service estimates recovery of the murrelet will require at least 50 years (USFWS 1997)

Recovery Plan

The Marbled Murrelet Recovery Plan outlines the conservation strategy with both short- and long-term objectives. The Plan places special emphasis on the terrestrial environment for habitat-based recovery actions due to nesting occurring in inland forests.

In the short-term, specific actions identified as necessary to stabilize the populations include protecting occupied habitat and minimizing the loss of unoccupied but suitable habitat (USFWS 1997, p. 119). Specific actions include maintaining large blocks of suitable habitat, maintaining and enhancing buffer habitat, decreasing risks of nesting habitat loss due to fire and windthrow, reducing predation, and minimizing disturbance. The designation of critical habitat also contributes towards the initial objective of stabilizing the population size through the maintenance and protection of occupied habitat and minimizing the loss of unoccupied but suitable habitat.

Long-term conservation needs identified in the Plan include:

- increasing productivity (abundance, the ratio of juveniles to adults, and nest success) and population size;
- increasing the amount (stand size and number of stands), quality, and distribution of suitable nesting habitat;
- protecting and improving the quality of the marine environment; and
- reducing or eliminating threats to survivorship by reducing predation in the terrestrial environment and anthropogenic sources of mortality at sea.

Recovery Zones in Washington

Conservation Zones 1 and 2 extend inland 50 miles from marine waters. Conservation Zone 1 includes all the waters of Puget Sound and most waters of the Strait of Juan de Fuca south of the U.S.-Canadian border and the Puget Sound, including the north Cascade Mountains and the northern and eastern sections of the Olympic Peninsula. Conservation Zone 2 includes marine waters within 1.2 miles (2 km) off the Pacific Ocean shoreline, with the northern terminus immediately south of the U.S.-Canadian border near Cape Flattery along the midpoint of the Olympic Peninsula and extending to the southern border of Washington (the Columbia River) (USFWS 1997, pg. 126).

Lands considered essential for the recovery of the murrelet within Conservation Zones 1 and 2 are 1) any suitable habitat in a Late Successional Reserve (LSR), 2) all suitable habitat located in the Olympic Adaptive Management Area, 3) large areas of suitable nesting habitat outside of LSRs on Federal lands, such as habitat located in the Olympic National Park, 4) suitable habitat on State lands within 40 miles off the coast, and 5) habitat within occupied murrelet sites on private lands (USFWS 1997).

Summary

At the range-wide scale, murrelet populations have declined at an average rate of 1.2 percent per year since 2001. The most recent population estimate for the entire Northwest Forest Plan area in 2013 was 19,700 murrelets (95 percent CI: 15,400 to 23,900 birds) (Falxa et al. 2015, p. 7). The largest and most stable murrelet subpopulations now occur off the Oregon and northern California coasts, while subpopulations in Washington have experienced the greatest rates of decline (-4.4 percent per year; 95% CI: -6.8 to -1.9%) (Lance and Pearson 2016, p. 5).

Monitoring of murrelet nesting habitat within the Northwest Forest Plan area indicates nesting habitat declined from an estimated 2.53 million acres in 1993 to an estimated 2.23 million acres in 2012, a decline of about 12.1 percent (Raphael et al. 2015b, p. 89). Murrelet population size is strongly and positively correlated with amount of nesting habitat, suggesting that conservation of remaining nesting habitat and restoration of currently unsuitable habitat is key to murrelet recovery (Raphael et al. 2011, p. iii).

The species decline has been largely caused by extensive removal of late-successional and old growth coastal forest which serves as nesting habitat for murrelets. Additional factors in its decline include high nest-site predation rates and human-induced mortality in the marine environment from disturbance, gillnets, and oil spills. In addition, murrelet reproductive success is strongly correlated with the abundance of marine prey species. Overfishing and oceanographic variation from climate events have likely altered both the quality and quantity of murrelet prey species (USFWS 2009, p. 67).

Although some threats have been reduced, most continue unabated and new threats now strain the ability of the murrelet to successfully reproduce. Threats continue to contribute to murrelet population declines through adult and juvenile mortality and reduced reproduction. Therefore, given the current status of the species and background risks facing the species, it is reasonable to assume that murrelet populations in Conservation Zones 1 and 2 and throughout the listed range have low resilience to deleterious population-level effects and are at high risk of continual declines. Activities which degrade the existing conditions of occupied nest habitat or reduce adult survivorship and/or nest success of murrelets will be of greatest consequence to the species. Actions resulting in the further loss of occupied nesting habitat, mortality to breeding adults, eggs, or nestlings will reinforce the current murrelet population decline throughout the coterminous United States.

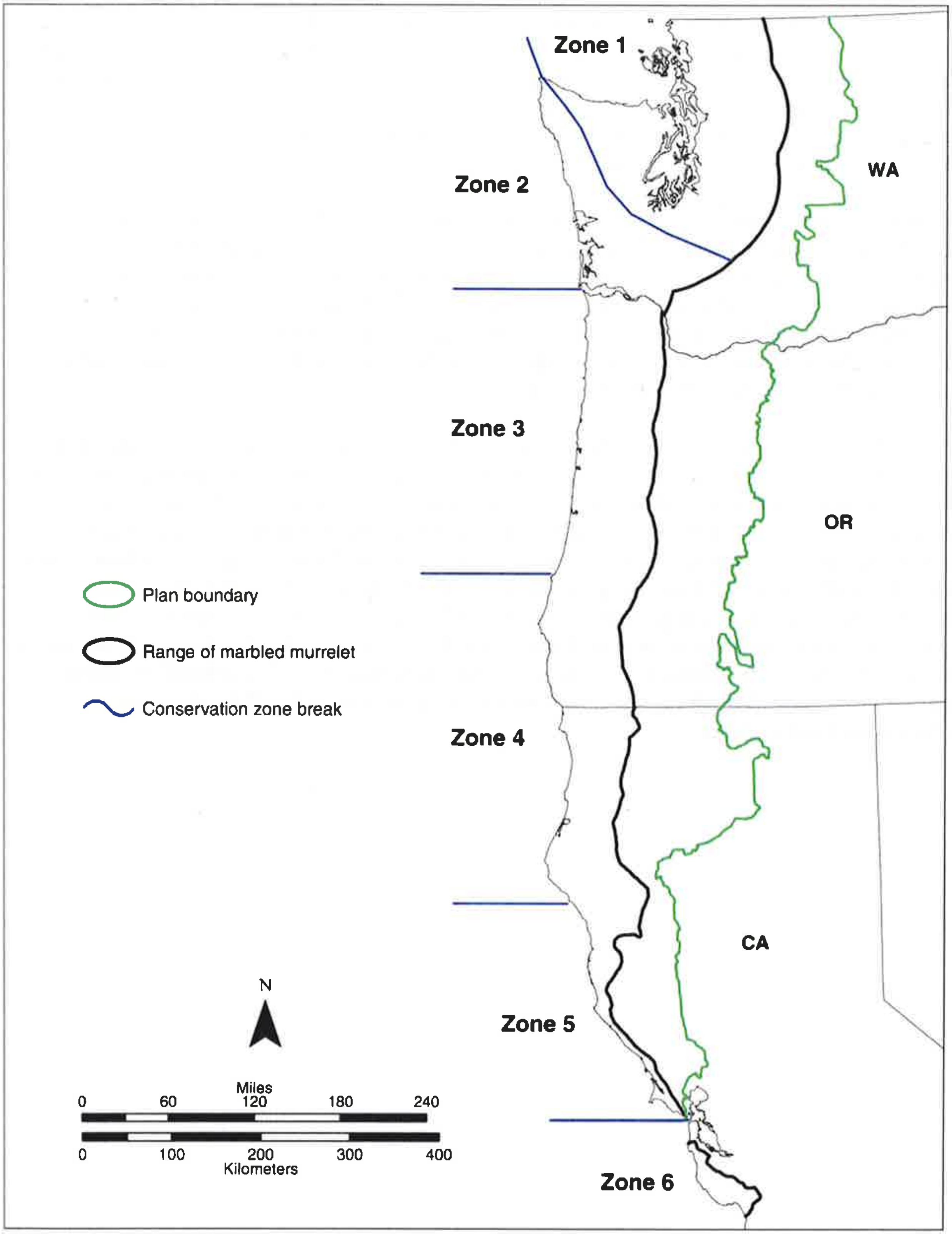

Figure 1. The six geographic areas identified as Conservation Zones in the recovery plan for the marbled murrelet (USFWS 1997). Note: "Plan boundary" refers to the Northwest Forest Plan. Figure adapted from Huff et al. (2006, p. 6).

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APPENDIX D
SNOHOMISH-SKYKOMISH BULL TROUT CORE AREA

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Appendix D
Snohomish-Skykomish Core Area

The Snohomish-Skykomish core area comprises the Snohomish, Skykomish, and Snoqualmie Rivers and their tributaries. Bull trout occur throughout the Snohomish River system downstream of barriers to anadromous fish. Bull trout are not known to occur upstream of Snoqualmie Falls, upstream of Spada Lake on the Sultan River, in the upper forks of the Tolt River, above Deer Falls on the North Fork Skykomish River, or above Alpine Falls on the Tye River. Bull trout did not occur above Sunset Falls on the South Fork Skykomish River prior to 1958, when the Washington Department of Fisheries (now Washington Department of Fish and Wildlife) implemented a trap-and-haul program for anadromous salmonids. This program is still operating.

Fluvial, resident, and anadromous life history forms of bull trout occur in the Snohomish-Skykomish core area. A large portion of the migratory segment of this population is anadromous. There are no lake systems within the basin that support typical adfluvial populations; however, anadromous and fluvial forma occasionally forage in a number of lowland lakes having connectivity to the mainstem rivers (USFWS 2004, p. 99).

The Snohomish, Snoqualmie, Skykomish, North Fork Skykomish, and South Fork Skykomish Rivers provide important foraging, migrating, and overwintering habitat for subadult and adult bull trout. The topography of the basin limits the amount of key spawning and early rearing habitat in comparison with many other core areas. Rearing bull trout occur throughout most of the accessible reaches of the basin and extensively use the lower estuary, nearshore marine areas, and Puget Sound for extended rearing.

In 2008, the Snohomish-Skykomish core area population was considered at "potential risk" for extirpation (USFWS 2008b, p. 35). Since 2008, some of the key status indicators have declined. The status of the bull trout core area population can be summarized by four key elements necessary for long-term viability: 1) number and distribution of local populations, 2) adult abundance, 3) productivity, and 4) connectivity (USFWS 2004, p. 215).

<u>Number and Distribution of Local Populations</u>

Four local populations are recognized within the Snohomish-Skykomish core area (USFWS 2004, pp. 99-105; USFWS 2015, p. A-14): 1) North Fork Skykomish River (including Goblin and West Cady Creeks), 2) Troublesome Creek (resident form only), 3) Salmon Creek, and 4) South Fork Skykomish River. Core areas with fewer than 5 interconnected local populations are at increased risk of local extirpation and adverse effects from random naturally-occurring events (USFWS 2004, pp. 216-218). Three of the four Snohomish-Skykomish core area local populations are interconnected (see Connectivity section below).

Adult Abundance

The Snohomish-Skykomish core area probably supports between 500 and 1,000 adults. In 2008, it was believed that this core area supported just over 1,000 adults (USFWS 2008a, p. 2; USFWS 2008b, p. 35). However, abundance indices in the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have substantially declined since then (WDFW 2015). From 2002 to 2007, North Fork redd counts averaged 305 redds, peaking at 538 redds in 2002. In contrast, from 2009 to 2014, counts averaged 90 redds, with a minimum of 17 redds observed in 2013, the lowest single-year count since surveys began in 1988. During the same time, spawner counts at the South Fork Skykomish River trap declined from a mean of 94 fish from 2002 to 2007, to a mean of 63 fish from 2009 to 2014. The Troublesome Creek local population is mainly a resident population upstream of a natural migration barrier. Adult abundance is unknown for this local population. The Salmon Creek local population likely has fewer than 100 adults.

The Snohomish-Skykomish core area is at risk from genetic drift because it likely contains fewer than 1,000 spawning adults per year (USFWS 2004, pp. 218-224). Two local populations (South Fork Skokomish River, Salmon Creek) are at risk from inbreeding depression because they are believed to contain fewer than 100 spawning adults per year (USFWS 2004, pp. 218-224). The North Fork Skykomish River local population is not at risk from inbreeding depression. Risk from inbreeding depression to the Troublesome Creek local population is unknown.

Productivity

Population trends for the two primary local populations (North Fork Skykomish River and South Fork Skykomish River) have been in decline since peaking in the early- to mid-2000's. Long-term redd counts for the North Fork Skykomish River local population increased from the time of listing, peaked between 2001 and 2004, and have generally been in decline since. The five-year running average from 2012 to 2014 varied between 83 and 118 redds, which is equivalent to pre-listing levels (75 to 118 redds) despite peaking at 348 to 366 redds between 2004 and 2006. A similar trend is evident in adult counts at the South Fork Skykomish River trap, although recent five-year running averages (62 to 66 adults) are still above pre-listing levels (38 to 44 adults). The five-year running average peaked between 2005 and 2007 at 95 to 102 adults. It is believed that the South Fork Skykomish River local population is continuing to colonize new spawning and rearing habitat, which may partially explain the less dramatic declining trend. Productivity of the Troublesome Creek and Salmon Creek local populations is unknown but presumed stable, as the available spawning and early rearing habitats are considered to be in good to excellent condition. The Snohomish-Skykomish core area is at increased risk of extirpation due to declining productivity (USFWS 2004, pp. 224-225).

Connectivity

Migratory bull trout occur in three of the four local populations in the Snohomish-Skykomish core area (North Fork Skykomish, Salmon Creek, and South Fork Skykomish). The lack of connectivity with the Troublesome Creek local population is a natural condition. The connectivity between the other three local populations reduces the risk of extirpation from habitat isolation and fragmentation. However, connectivity with the South Fork Skykomish local population is dependent upon the trap-and-haul facility at Sunset Falls.

Changes in Environmental Conditions

Since the bull trout listing, federal actions occurring in the Snohomish-Skykomish core area have had short- and long-term effects to bull trout and bull trout habitat, and have both positively and negatively affected bull trout. These actions have included: statewide federal restoration programs with riparian restoration, replacement of fish passage barriers, and fish habitat improvement projects; federally funded transportation projects involving repair and protection of roads and bridges; and section 10(a)(1)(B) permits for Habitat Conservation Plans addressing forest management practices. Capture and handling during implementation of section 6 and section 10(a)(1)(A) permits have directly affected bull trout in the Snohomish-Skykomish core area.

The number of non-federal actions occurring in the Snohomish-Skykomish core area since the bull trout listing is unknown. However, activities conducted on a regular basis, such as emergency flood control, development, and infrastructure maintenance, affect riparian and instream habitat and probably negatively affect bull trout.

Climate change is expected to negatively affect the Snohomish-Skykomish core area (USFWS 2008a, p. 14). Climate change is expected to result in higher water temperatures, lower spawning flows, and increased magnitude of winter peak flows (Battin et al. 2007 in USFWS 2008a, p. 14). Higher peak flows may increase redd scour and mortality to eggs, incubating embryos, and pre-emergent juveniles. Bull trout spawning and rearing areas are particularly vulnerable to future climate change impacts, especially due to the narrow distribution of spawning sites within this system (USFWS 2008a, p. 14).

Threats

There are four primary threats to bull trout in the Snohomish-Skykomish core area (USFWS 2015, p. A-14):

Instream Impacts: Flood Control. Flood and erosion control associated with agricultural practices, residential development, and urbanization continues to result in poor structural complexity within lower river FMO habitats key to the persistence of the anadromous life history form.

Instream Impacts: Recreational Mining. Recreational mining activities impact spawning and rearing tributary habitats.

Water Quality: Residential Development and Urbanization. Associated impacts increase seasonal high water temperature in lower mainstem rivers, migration corridors that are key to the persistence of the anadromous life history form.

Connectivity Impairment: Fish Passage Issues. Persistence of the South Fork Skykomish River local population is reliant upon continued funding and ongoing operation of the trap-and-haul facility at Sunset Falls.

Additional threats to the Snohomish-Skykomish core area bull trout population include the following:

- Degraded habitat conditions from effects associated with timber harvests, logging roads, and timber land fertilization, especially in the upper watershed, where spawning occurs.
- Blocked fish passage, altered stream morphology, and degraded water quality in the lower watershed resulting from agricultural and livestock management practices.
- Injury and/or mortality from illegal harvest or incidental hooking/netting, which may occur where recreational fishing is allowed by the Washington Department of Fish and Wildlife.
- Degraded water quality from municipal and industrial effluent discharges and development.
- Degradation of riparian areas due to residential development and urbanization, and associated loss of foraging habitat and prey.

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APPENDIX E
SEDIMENT ANALYSIS FRAMEWORK

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Appendix E
Sediment Analysis Framework

There are numerous factors that can influence project-specific sediment effects on bull trout and other salmonids. These factors include the concentration and duration of sediment input, existing sediment conditions, stream conditions (velocity, depth, etc.) during construction, weather or climate conditions (precipitation, wind, etc.), fish presence or absence (bull trout plus prey species), and best management practice effectiveness. Many of these factors are unknown.

Newcombe and Jensen (1996) and Anderson et al. (1996) provide the basis for analyzing sediment effects to bull trout and other salmonids and their habitat. Newcombe and Jensen (1996) conducted a literature review of pertinent documents on sediment effects to salmonids and nonsalmonids. They developed a model that calculated the severity of ill effect (SEV) to fish based on the suspended sediment dose (exposure) and concentration. No data on bull trout were used in this analysis. Anderson et al. (1996), using the methods used by Newcombe and Jensen (1996), developed a model to estimate sediment impacts to salmonid habitat.

A 15-point scale was developed by Newcombe and Jensen (1996, p. 694) to qualitatively rank the effects of sediment on fish (Table 1). Using a similar 15-point scale, Anderson et al. (1996) ranked the effects of sediment on fish habitat (Table 2).

We analyzed the effects on different bull trout life history stages to determine when adverse effects of project-related sediment would occur. Table 3 shows the different ESA effect calls for bull trout based on severity of ill effect.

Table 1 – Scale of the severity (SEV) of ill effects associated with excess suspended sediment on salmonids.

SEV	Description of Effect
	Nil effect
0	No behavioral effects
	Behavioral effects
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
	Sublethal effects
4	Short-term reduction in feeding rates; short-term reduction in feeding success
5	Minor physiological stress; increase in rate of coughing; increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Lethal and paralethal effects
9	Reduced growth rate; delayed hatching; reduced fish density
10	0-20% mortality; increased predation; moderate to severe habitat degradation
11	> 20 – 40% mortality
12	> 40 – 60% mortality
13	> 60 – 80% mortality
14	> 80 – 100% mortality

The effect determination for a proposed action should consider all SEV values resulting from the action because sediment affects individual fish differently depending on life history stage and site-specific factors. For juvenile bull trout, an SEV of 5 is likely to warrant a "likely to adversely affect" (LAA) determination. However, abandonment of cover (SEV 2), or an avoidance response (SEV 3), may result in increased predation risk and mortality if habitat features are limiting in the project's stream reach. Therefore, a LAA determination may be warranted at an SEV 2 or 3 level in certain situations. For subadult and adult bull trout, however, abandonment of cover and avoidance may not be as important. A higher SEV score is more appropriate for adverse effects to subadult and adult bull trout. In all situations, we assume that SEV scores associated with adverse effects are also sufficient to represent a likelihood of harm or harass[1].

Table 2 – Scale of the severity (SEV) of ill effects associated with excess suspended sediment on salmonid habitat.

SEV	Description of Effect
3	Measured change in habitat preference
7	Moderate habitat degradation – measured by a change in invertebrate community
10	Moderately severe habitat degradation – defined by measurable reduction in the productivity of habitat for extended period (months) or over a large area (square kilometers).
12	Severe habitat degradation – measured by long-term (years) alterations in the ability of existing habitats to support fish or invertebrates.
14	Catastrophic or total destruction of habitat in the receiving environment.

When evaluating impacts to habitat as a surrogate for species effects, adverse effects may be anticipated when there is a notable reduction in abundance of aquatic invertebrates, and an alteration in their community structure. These effects represent a reduction in food for bull trout and other salmonids, and correspond to an SEV of 7 – moderate habitat degradation.

Newcombe and Jensen (1996) used six data groups to conduct their analysis. These groups were 1) juvenile and adult salmonids (Figure 1), 2) adult salmonids (Figure 2), 3) juvenile salmonids (Figure 3), 4) eggs and larvae of salmonids and non-salmonids (Figure 4), 5) adult estuarine nonsalmonids (no figure provided), and 6) adult freshwater nonsalmonids (no figure provided). No explanation was provided for why juvenile and adult salmonids were combined for group 1. As juveniles are more adapted to turbid water (Newcombe 1994, p. 5), their SEV levels are generally lower than for adult salmonids given the same concentration and duration of sediment (Figures 1-3).

[1] Harm and harass in this context refers to the FWS's regulatory definition at 50 CFR 17.3. E.g., Harm means "an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering."

Table 3 – ESA Effect calls for different bull trout life stages in relation to the duration of effect and severity of ill effect. Effect calls for habitat, specifically, are provided to assist with analysis of effects to individual bull trout.		
	SEV	**ESA Effect Call**
Egg/alevin	1 to 4	Not applicable - alevins are still in gravel and are not feeding.
	5 to 14	LAA - any stress to egg/alevin reduces survival
Juvenile	1 to 4	NLAA
	5 to 14	LAA
Subadult and Adult	1 to 5	NLAA
	6 to 14	LAA
Habitat	1 to 6	NLAA
	7 to 14	LAA due to indirect effects to bull trout

The figures of Newcombe and Jensen (1996) have been modified in this document. In each figure, values (in mg/L) are provided for each duration to determine when adverse effects would occur. Specific values are also given for when harm would be likely to occur. For example:

> Figure 1 – This figure is for both juveniles and adults. From Table 2, bull trout are "likely to be adversely affected" given an SEV of 5. On Figure 1, a sediment concentration of 99 mg/L for one hour is anticipated to be the maximum concentration for an SEV of 4. At 100 mg/L, an SEV of 5 occurs. In addition, one hour of exposure to 5,760 mg/L is the maximum for an SEV of 7. Exposure to 5,761 mg/L for one hour would warrant an SEV of 8. This would be the threshold between harassment and harm. An SEV of 7 would be harassment, and an SEV of 8 would be considered harm.

The following provides some guidance on use of the figures.

Definitions from Newcombe and Jensen (1996, p. 696). These definitions are provided for consultations that may have impacts to bull trout prey such as Chinook and coho salmon.

> Eggs and larvae – eggs, and recently hatched fish, including yolk-sac fry, that have not passed through final metamorphosis.
>
> Juveniles – fry, parr, and smolts that have passed through larval metamorphosis but are sexually immature.
>
> Adults – mature fish.

Bull trout use:

Newcombe and Jensen (1996) conducted their analysis for freshwater, therefore the use of the figures within this document in marine waters should be used with caution.

Figure 1 – Juvenile and Adult Salmonids. This figure should be used in foraging, migration and overwintering (FMO) areas. In FMO areas, downstream of local populations, both subadult and adult bull trout may be found.

Figure 2 – Adult Salmonids. This figure will not be used very often for bull trout. There may be circumstances, downstream of local population spawning areas that may have just adults, but usually this would not be the case. Justification for use of this figure should be stated in your consultation.

Figure 3 – Juvenile Salmonids. This figure should be used in local population spawning and rearing areas outside of the spawning period. During this time, only juveniles and sub-adults should be found in the area. Adults would migrate to larger stream systems or to marine water. If the construction of the project would occur during spawning, then Figure 1 should be used.

Figure 4 – Eggs and Alevins. This figure should be used if eggs or alevins are expected to be in the project area during construction.

Figure 5 – Habitat. This figure should be used for all projects to determine whether alterations to the habitat may occur from the project.

Background and Environmental Baseline

In determining the overall impact of a project on bull trout, and to specifically understand whether increased sediment may adversely affect bull trout, a thorough review of the environmental baseline and limiting factors in the stream and watershed is needed. The following websites and documents will help provide this information.

1. Washington State Conservation Commission's Limiting Factors Analysis. A limiting factors analysis has been conducted on watersheds within the State of Washington. Limiting factors are defined as "conditions that limit the ability of habitat to fully sustain populations of salmon, including all species of the family Salmonidae." These documents will provide information on the current condition of the individual watersheds within the State of Washington. The limiting factors website is http://salmon.scc.wa.gov. Copies of the limiting factors analysis can be found at the Western Washington Fish and Wildlife Library.

2. Washington Department of Fish and Wildlife's (1998) Salmonid Stock Inventory (SaSI). The Washington Department of Fish and Wildlife (WDFW) inventoried bull trout and Dolly Varden (*S. malma*) stock status throughout the State. The intent of the inventory is to help identify available information and to guide future restoration planning and implementation. SaSI defines the stock within the watershed, life history forms, status and factors affecting production. Spawning distribution and timing for different life stages are provided (migration, spawning, etc.), if known. SaSi documents can be found at http://wdfw.wa.gov/fish/sasi/index.htm.

3. U.S. Fish and Wildlife Service's (USFWS 1998a) Matrix of Diagnostics/Pathways and Indicators (MPI). The MPI was designed to facilitate and standardize determination of project effects on bull trout. The MPI provides a consistent, logical line of reasoning to aid in determining when and where adverse affects occur and why they occur. The MPI provides levels or values for different habitat indicators to assist the biologist in determining the level of effects or impacts to bull trout from a project and how these impacts may cumulatively change habitat within the watershed.

4. Individual Watershed Resources. Other resources may be available within a watershed that will provide information on habitat, fish species, and recovery and restoration activities being conducted. The action agency may cite a publication or identify a local watershed group within the Biological Assessment or Biological Evaluation. These local groups provide valuable information specific to the watershed.

5. Washington State Department of Ecology (WDOE) - The WDOE has long- and short-term water quality data for different streams within the State. Data can be found at http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html. Clicking on a stream or entering a stream name will provide information on current and past water quality data (when you get to this website, scroll down to the Washington map). This information will be useful for determining the specific turbidity/suspended sediment relationship for that stream (more information below).

6. Washington State Department of Ecology (WDOE) - The WDOE has also been collecting benthic macroinvertebrates and physical habitat data to describe conditions under natural and anthropogenic disturbed areas. Data can be found at http://www.ecy.wa.gov/programs/eap/fw_benth/index.htm. You can access monitoring sites at the bottom of the website.

7. U.S. Forest Service, Watershed Analysis Documents - The U.S. Forest Service (USFS) is required by the Record of Decision for Amendments to the USFS and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl to conduct a watershed analysis for watersheds located on FS lands. The watershed analysis determines the existing condition of the watershed and makes recommendations for future projects that move the landscape towards desired conditions. Watershed analysis documents are available from individual National Forests or from the Forest Plan Division.

8. U.S. Fish and Wildlife Service - Bull Trout Recovery Plans and Critical Habitat Designations. The draft Bull Trout Recovery Plan for the Columbia River Distinct Population Segment (DPS) (also the Jarbidge River and the St. Mary-Belly River DPS) and the proposed and final critical habitat designations provide current species status, habitat requirements, and limiting factors for bull trout within specific individual recovery units. These documents are available from the Endangered Species Division as well as the Service's web page (www.fws.gov).

These documents and websites provide baseline and background information on stream and watershed conditions. This information is critical to determining project-specific sediment impacts to the aquatic system. The baseline or background levels need to be analyzed with respect to the limiting factors within the watershed.

Consultation Sediment Analysis

The analysis in this section only applies to construction-related physiological and behavioral impacts, and the direct effects of fine sediment on current habitat conditions. Longer-term effects to habitat from project-induced channel adjustments, post-construction inputs of coarse sediment, and secondary fine sediment effects due to re-mobilization of sediment during the following runoff season, are not included in the quantitative part of this effects determination. Those aspects are only considered qualitatively.

The background or baseline sediment conditions within the project area or watershed will help to determine whether the project will have an adverse effect on bull trout. The following method should be followed to assist in reviewing effects determinations and quantifying take in biological opinions.

1) Determine what life stage(s) of bull trout will be affected by sedimentation from the project. Life history stages include eggs and alevins, juveniles, and sub-adults and adults. If projects adhere to approved work timing windows, very few should be constructed during periods when eggs and alevins are in the gravels. However, streambed or bank adjustments may occur later in time and result in increased sedimentation during the time of the year when eggs and alevins may be in the gravels and thus affected by the project.

2) Table 4 provides concentrations, durations, and SEV levels for different projects. This table will help in analyzing similar projects and to determine sediment level impacts associated with that type of project. Based on what life history stage is in the project area and what SEV levels may result from the project, a determination may be made on effects to bull trout. (Table 4 located on the Q drive: Q:\linked Literature Materials\Species & Issues & BO Templates with RefMan\Sediment Issue Paper)

3) Once a "likely to adversely affect" determination has been made for a project, the figures in Newcombe and Jensen (1996) or Anderson et al. (1996) are used to determine the concentration (mg/L) at which adverse effects[2] and "take" will occur (see Figures 1-5). For example, if a project is located in FMO habitat, Figure 1 would be used to determine the concentrations at which adverse effects will occur. Since Figure 1 is used for both adults and juveniles, an SEV of 5 (for juveniles) is used (see Table 2). For (a.) the level when instantaneous adverse effects occur, find the SEV level of 5 in the one hour column. The corresponding concentration is the instantaneous value where adverse affects occur. In this example, it is 148 mg/L. For (b), (c), and (d), adverse effects will occur when sediment concentrations exceed SEV 4 levels. The exact concentrations for

[2] For the remainder of the document, references to "adverse effects" also refer to harm and harass under 50 CFR 17.3.

this have been provided. For each category, find the SEV 4 levels and the corresponding concentration levels are the values used.

For impacts to individual bull trout, adverse effects would be anticipated in the following situations:

a. Any time sediment concentrations exceed 148 mg/L over background.
b. When sediment concentrations exceed 99 mg/L over background for more than one hour continuously.
c. When sediment concentrations exceed 40 mg/L over background for more than three hours cumulatively.
d. When sediment concentrations exceeded 20 mg/L over background for over seven hours cumulatively.

For habitat effects, use Figure 5 and the same procedure as above for individual bull trout. For example, adverse effects would be expected to occur in the following situations:

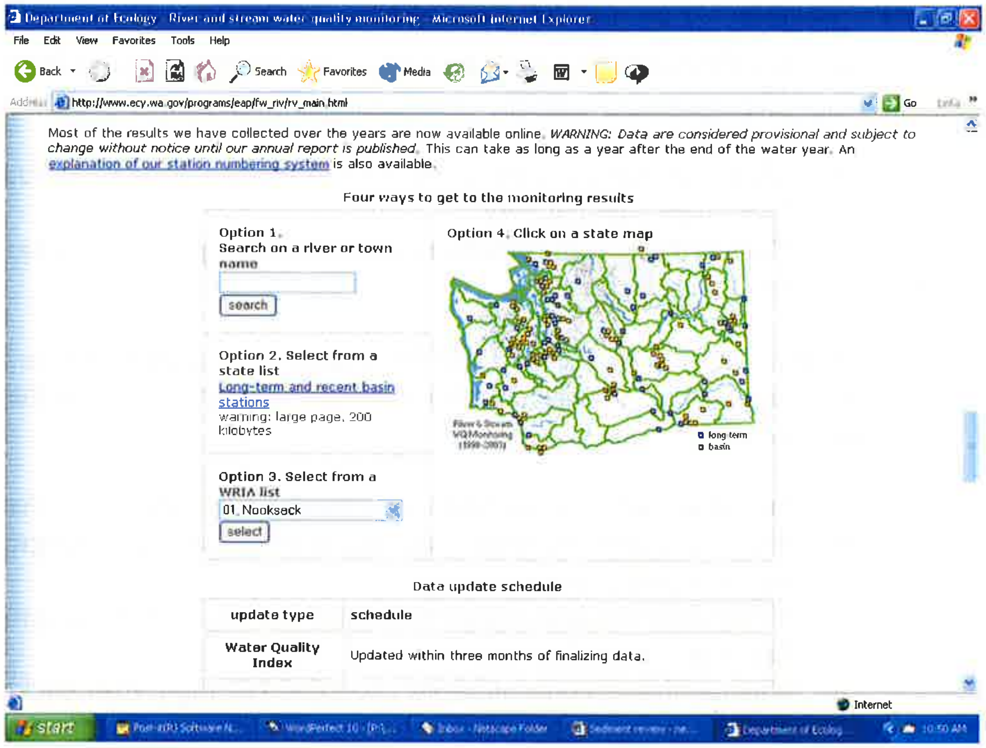
a. Any time sediment concentrations exceed 1,097 mg/L over background.
b. When sediment concentrations exceed 885 mg/L over background for more than one hour continuously.
c. When sediment concentrations exceed 345 mg/L over background for more than three hours cumulatively.
d. When sediment concentrations exceeded 167 mg/L over background for over seven hours cumulatively.

4) Because sediment sampling for concentration (mg/L) is labor intensive, many applicants prefer to monitor turbidity as a surrogate. To do this, the sediment concentration at which adverse effects to the species and/or habitat occurs is converted to NTUs. Two methods, regression analysis and turbidity to suspended solid ratio, are available for this conversion. The regression analysis method should be used first. If not enough data are available then the turbidity to suspended solid ratio method should be used.

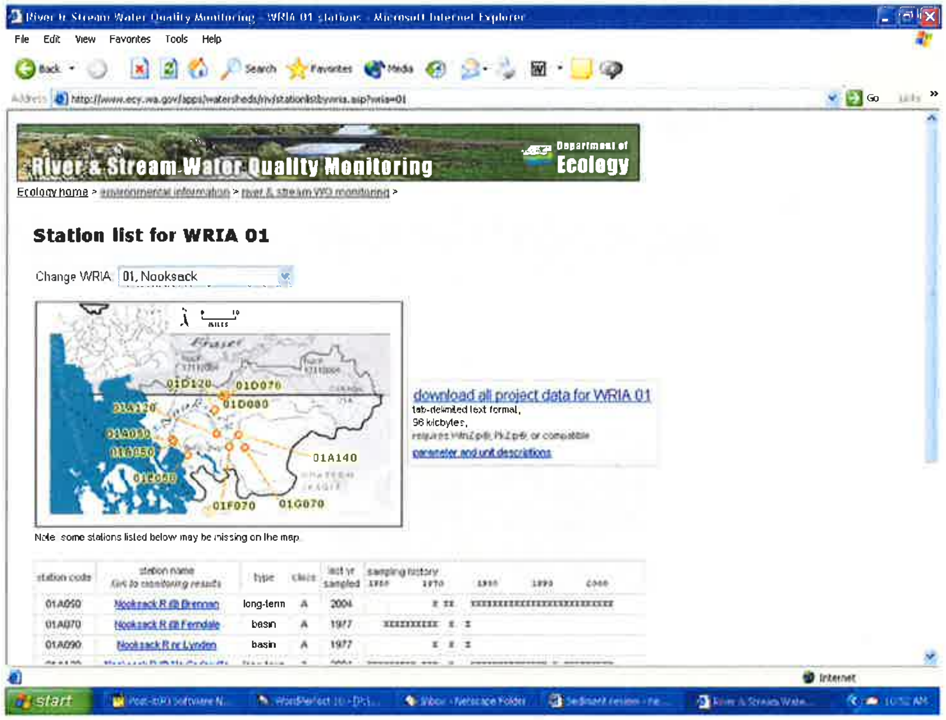
    a. Data – as described above in Background and Environmental Baseline, an attempt should be made to find turbidity and suspended solid information from the project area, action area, or the stream in which the project is being constructed. This information may be available from the Tribes, watershed monitoring groups, etc. Try to obtain information for the months in-water construction will occur, which is usually during the fish timing window (in most cases, July through September). If you are unable to find any data for the action area, use the WDOE water quality monitoring data. The following are the steps you need to go through to locate the information on the web and how to download the data:

        i. Go to the WDOE webpage (http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html).

ii. When you get to the website, the page will state “River and Stream Water Quality Monitoring.” If you scroll down the page, you will see the following text and map.



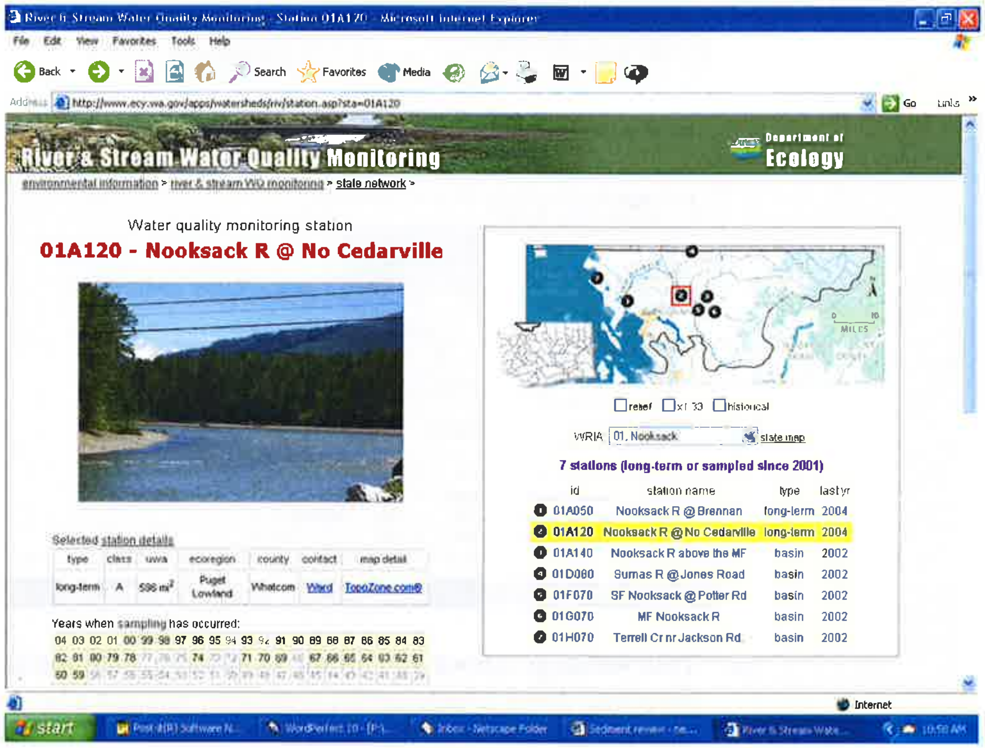
iii. The map shows all the water quality monitoring stations in Washington. You can click on a watershed, or go to Option 3, click on the down arrow and find your watershed. You will then get the following webpage. This is an example for the Nooksack River.



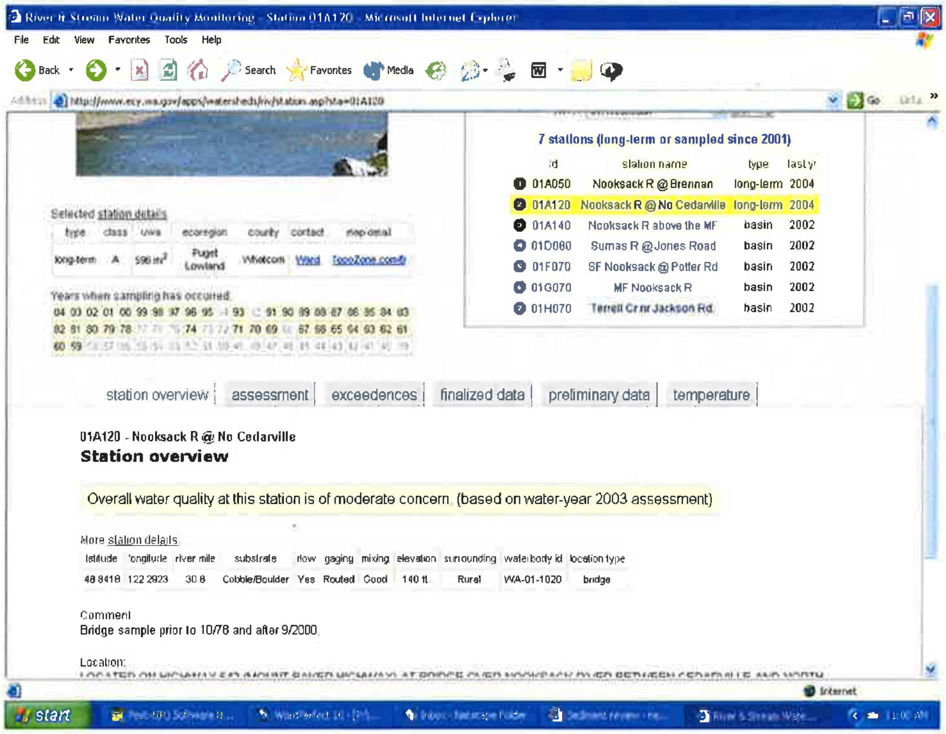
iv. This webpage shows you all the monitoring stations in this watershed. Scrolling down a little on the webpage, you get a list of the monitoring stations and the years that data were collected. The more years in which data were collected the better; however, you want to pick the monitoring station closest to the project site. If a project is located on a tributary, do not use data from the main river in the watershed. Find a monitoring station on a tributary and use that data. **Justification for the use of the data needs to be made in the BO.** The following language was used in the Anthracite Creek Bridge Scour BO. Changes to this paragraph to represent regression analysis are not italicized.

"*The guidance of Newcombe and Jensen* (1996) *requires a measurement of the existing suspended sediment concentration levels (mg/L) and duration of time that sediment impacts would occur. The Service used data available on the Washington Department of Ecology (WDOE) website to determine a ratio of turbidity (NTU) to suspended solids (mg/L)*(website to find the correlation between turbidity and suspended solids) *in Anthracite Creek. No water quality data was available for Anthracite Creek, so the Service used water quality monitoring data from a different tributary within the Snohomish River watershed. Patterson Creek, which is a tributary to the Snoqualmie River, was used to determine the ratio of turbidity to suspended solids* (correlation between turbidity and suspended solids). *The Service believes that Patterson Creek would have very comparable water quality data as Anthracite Creek. The turbidity to suspended solid ratio for Patterson Creek is 1:2.4 during the proposed months of construction (July through September).*" Delete the last sentence for regression analysis or put in the equation used for analysis and the R^2.

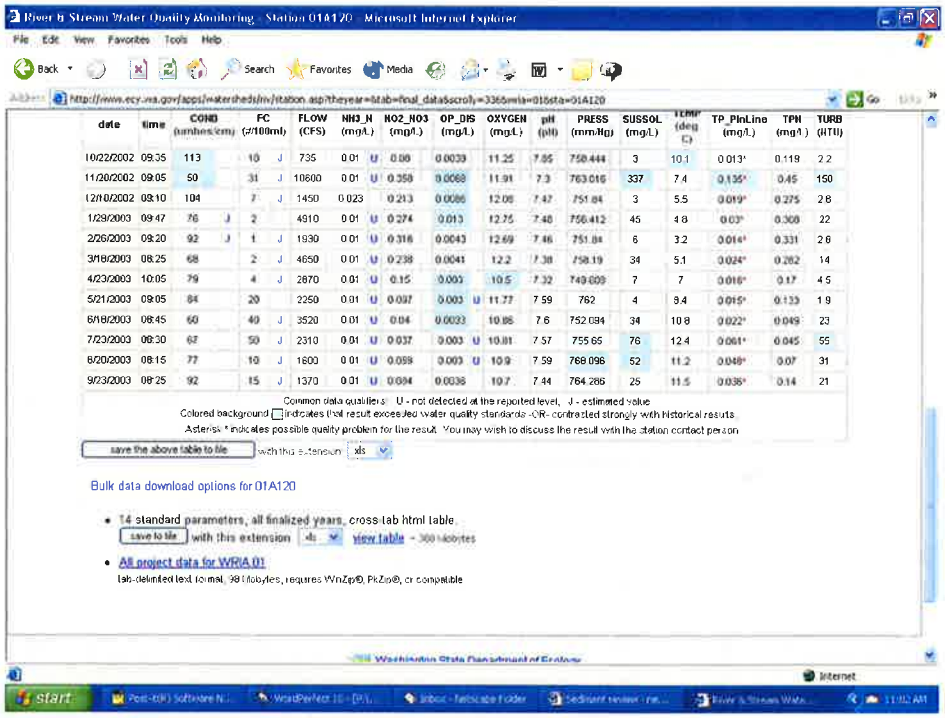
v. When you select the monitoring station, the following webpage appears. This monitoring station is on the Nooksack River at North Cedarville.



vi. Moving down the webpage, you find the following. The page shows the years data were collected and 4 to 6 tabs that provide different information. Click on the finalized data tab.



vii. Selecting the finalized data, a new page comes up; scrolling down that page you see the following. The top part of the page shows the finalized data for the most recent year data were collected. Below the data is a box that says "Bulk data download options..." Click on the "save to file" button for the 14 standardized data parameters. Follow the instructions to save this file. This saves all the data from that monitoring station so the regression analysis can be conducted.



date	time	COND (umhos/cm)	FC (#/100ml)	FLOW (CFS)	NH3_N (mg/L)	NO2_NO3 (mg/L)	OP_DIS (mg/L)	OXYGEN (mg/L)	pH (pH)	PRESS (mm/Hg)	SUSSOL (mg/L)	TEMP (deg C)	TP_PlnLine (mg/L)	TPN (mg/L)	TURB (NTU)
10/22/2002	09:35	113	10 J	735	0.01 U	0.08	0.0033	11.25	7.85	758.444	3	10.1	0.013*	0.119	2.2
11/20/2002	09:05	50	31 J	10600	0.01 U	0.358	0.0068	11.91	7.3	763.016	337	7.4	0.135*	0.45	150
12/10/2002	09:10	104	7 J	1450	0.023	0.213	0.0086	12.08	7.47	751.84	3	5.5	0.019*	0.275	2.8
1/29/2003	09:47	76 J	2	4910	0.01 U	0.274	0.013	12.75	7.48	758.412	45	4.8	0.03*	0.308	22
2/26/2003	09:20	92 J	1 J	1930	0.01 U	0.316	0.0043	12.69	7.46	751.84	6	3.2	0.014*	0.331	2.8
3/18/2003	08:25	68	2 J	4650	0.01 U	0.238	0.0041	12.2	7.38	758.19	34	5.1	0.024*	0.282	14
4/23/2003	10:05	79	4 J	2870	0.01 U	0.15	0.003	10.5	7.32	749.809	7	7	0.016*	0.17	4.5
5/21/2003	09:05	84	20	2250	0.01 U	0.037	0.003 U	11.77	7.59	762	4	9.4	0.015*	0.133	1.9
6/18/2003	08:45	60	40 J	3520	0.01 U	0.04	0.0033	10.86	7.6	752.094	34	10.8	0.022*	0.049	23
7/23/2003	08:30	67	50 J	2310	0.01 U	0.037	0.003 U	10.81	7.57	755.65	76	12.4	0.061*	0.045	55
8/20/2003	08:15	77	10 J	1600	0.01 U	0.098	0.003 U	10.9	7.59	768.096	52	11.2	0.048*	0.07	31
9/23/2003	08:25	92	15 J	1370	0.01 U	0.084	0.0036	10.7	7.44	764.286	25	11.5	0.036*	0.14	21

Common data qualifiers: U - not detected at the reported level, J - estimated value

Colored background ☐ indicates that result exceeded water quality standards -OR- contrasted strongly with historical results

Asterisk * indicates possible quality problem for the result. You may wish to discuss the result with the station contact person

save the above table to file with this extension xls

viii. Open Excel and open the file that was just downloaded. Verify that all data appear to be available. After you have worked with these files, you will get an idea if something appears wrong. If the data looks like something is wrong, verify it by comparing the data to the finalized data on the webpage (look at each year's finalized data). After the file is open, delete all columns except the date, sussol (mg/L) and turb (NTU).

ix. Next delete the rows that do not need to be included. Only save the months in which the project will be constructed. For example, if work will be conducted during the work timing window of July 15 through August 31, delete all rows except those that contain data for July and August. The data consist of one data collection point each month. In addition, delete any values that have a "U" or "J" in the column to the right of the NTU value. This data may not be accurate; data may not be detectable at reported level or is an estimated value. The blue cells indicate the value exceeds water quality standards or contrasted strongly with historical results.

x. After deleting the unnecessary columns and rows, your data should contain 5 columns. You can now delete the columns to the right of the values. This will give you 3 columns. The first being the date, the second column contains the suspended solid data (mg/L) and the third column the turbidity (NTU) data.

b. Regression analysis. Once you have the data reduced to the months construction will occur, you can determine the relationship between turbidity and suspended solids using regression. The following steps will provide the regression equation using the data obtained above. These steps are for Excel 2007.

i. With your mouse, highlight both columns of data (suspended solid and turbidity), but do not include the heading information.

ii. Then click on "Insert", "Scatter" and then the graph that does not have any lines on it (should be the upper left graph).

iii. The graph is placed on your Excel sheet, so move it over so you can see all the data and the graph.

iv. Now add the trendline to the graph. This is done by clicking (left button) once on any of the points on the graph. Then right click. A window pops open and click on "Add Trendline." A "Format Trendline" window appears. Make sure Linear is checked, and down on the bottom, check Display Equation on chart and Display R-squared value on chart. Click on close.

    1. The X and Y data are opposite of what you want so you need to swap the values. This is done by left clicking once anywhere on the graph and then right click and click on "select data." A window pops open and you want to click on Edit. An Edit Series window appears and you want to click on the little red arrow next to Series X values. This allows you to select the data in the table. Upon clicking the red arrow, you will see the column under sussol (mg/L) being selected by a moving line around the cells. Select the data under Turb (NTU) by left clicking and holding the button down and drag all the way down to the last cell in that column. The whole column should have the moving line around all the cells. Click on the little red arrow in the Edit Series window. That will expand out the window and you will do the same for the Series Y values. Click on the red arrow next to that, then left click and hold and select all the cells in the column under Sussol (mg/L), and then click on the red arrow again. When the Edit Series window expands, click on OK, and then click on OK.

v. The equation that you want to use for your conversion from NTUs to suspended solids is now on the graph. Hopefully, your R-squared value is also high. This gives you an indication of how well your data fits the line. A one (1) is perfect. If this number is low (and a ballpark figure is less than 0.60) then you may want to consider using the ratio method to determine your conversion from NTUs to suspended solids.

    1. Outliers – sometimes there will be data that will be far outside the norm. These values can be deleted and that will help increase your R-squared value. If you are good at statistics there are ways of

determining outliers. If not, you will probably just use the data as is, unless you think something is really not right, then you may want to delete those data points.

vi. Using the equation for the regression analysis, convert the sediment concentrations found for when adverse affects occur to bull trout and their habitat (number 3 above) to NTUs. For our example, let's say our NTU to suspended solid equation is: $y = 1.6632x - 0.5789$. Adverse effects would then occur at (solve for x):

For impacts to the species adverse effect would occur in the following situations:

a. Any time sediment concentrations exceed 89 NTU over background.
b. When sediment concentrations exceed 60 NTU over background for more than one hour continuously.
c. When sediment concentrations exceed 24 NTU over background for more than three hours cumulatively.
d. When sediment concentrations exceeded 12 NTU over background for over seven hours cumulatively.

For impacts to habitat

a. Any time sediment concentrations exceed 660 NTU over background.
b. When sediment concentrations exceed 532 NTU over background for more than one hour continuously.
c. When sediment concentrations exceed 208 NTU over background for more than three hours cumulatively.
d. When sediment concentrations exceeded 101 NTU over background for over seven hours cumulatively.

c. Turbidity:suspended solid ratio: To calculate the turbidity to suspended solid ratio you need to download the same data off the Ecology website as described above. Sometimes the monitoring stations have limited amount of data and by running the regression analysis it is possible to get a negative slope (an increase in turbidity results in a decrease in suspended solids). This is very unlikely to occur in a stream. Other times you have so few data points that the R^2 value shows that the correlation between suspended solid and turbidity is not very good. When R^2 values are below 0.60, determine the turbidity to suspended solid ratio. The following are the steps needed to calculate the turbidity to suspended solid ratio.

i. After you deleted all the columns and rows of data you do not need, you should have 3 columns of data. The first being the date, the second column contains the suspended solid data (mg/L) and the third column the turbidity (NTU) data.

ii. Calculate the average turbidity and suspended solid value for all data. Average the turbidity column and average the suspended solid column.

iii. Calculate the turbidity to suspended solid value for the average turbidity and average suspended solid value obtained in ii. Divide the average suspended solid value by the average turbidity value.

iv. If any outliers are identified, they should be deleted. Recalculate the turbidity:suspended solid ratio if outliers have been removed (should automatically be done when values are deleted).

vii. Using the turbidity to suspended solid ratio, convert the sediment concentrations found for when adverse effects occur to bull trout and their habitat (number 3 above) to NTUs. For our example, let's say our NTU to suspended solid ratio is 2.1. Adverse effects to the species would then occur in the following situations:

a. Any time sediment concentrations exceed 70 NTU over background.
b. When sediment concentrations exceed 47 NTU over background for more than one hour continuously.
c. When sediment concentrations exceed 19 NTU over background for more than three hours cumulatively.
d. When sediment concentrations exceeded 10 NTU over background for over seven hours cumulatively.

Adverse effects to the species through habitat impacts would occur in the following situations:
a. Any time sediment concentrations exceed 522 NTU over background.
b. When sediment concentrations exceed 421 NTU over background for more than one hour continuously.
c. When sediment concentrations exceed 164 NTU over background for more than three hours cumulatively.
a. When sediment concentrations exceeded 80 NTU over background for over seven hours cumulatively.

5) Determine how far downstream adverse effects and take will occur. There is no easy answer for determining this. Table 4 provides some sediment monitoring data for a variety of projects. These data can be used to determine the downstream extent of sediment impacts for a project. Note that in Table 4 there is not a single downstream point that can always be used because sediment conveyance and mixing characteristics are different for each stream. **An explanation of how the distance downstream was determined needs to be included in each BO.**

Figure 1 – Severity of ill effect scores for juvenile and adult salmonids. The individual boxes provide the maximum concentration for that SEV. The concentration between 4 and 5 represents the threshold for harassment, and the concentration between 7 and 8 represents the threshold for harm.

Juvenile and Adult Salmonids
Average severity of ill effect scores

Concentration (mg/L)	Hours			Days			Weeks		Months		
	1	3	7	1	2	6	2	7	4	11	30
162755	10	11	11	12	12	13	14	14	-	-	-
59874	9	10	10	11	12	12	13	13	14	-	-
22026	8	9	10	10	11	11	12	13	13	14	-
8103	8	8	9	10	10	11	11	12	13	13	14
2981	$\boxed{5760}$ 7	8	8	9	9	10	11	11	12	12	13
1097	6	$\boxed{2335}$ 7	$\boxed{1164}$ 7	8	9	9	10	10	11	12	12
403	5	6	7	$\boxed{491}$ 7	8	9	9	10	10	11	12
148	5	5	6	7	$\boxed{214}$ 7	8	8	9	10	10	11
55	$\boxed{99}$ 4	5	5	6	6	$\boxed{95}$ 7	8	8	9	9	10
20	3	$\boxed{40}$ 4	$\boxed{20}$ 4	5	6	6	$\boxed{42}$ 7	8	8	9	9
7	3	3	4	$\boxed{8}$ 4	5	6	6	$\boxed{18}$ 7	$\boxed{8}$ 7	8	9
3	2	2	3	4	$\boxed{4}$ 4	5	5	6	7	$\boxed{4}$ 7	8
1	1	2	2	3	3	$\boxed{2}$ 4	5	5	6	7	$\boxed{2}$ 7

Figure 2 - Severity of ill effect scores for adult salmonids. The individual boxes provide the maximum concentration for that SEV. The concentration between 5 and 6 represents the threshold for harassment, and the concentration between 7 and 8 represents the threshold for harm.

Adult Salmonids
Average severity of ill effect scores

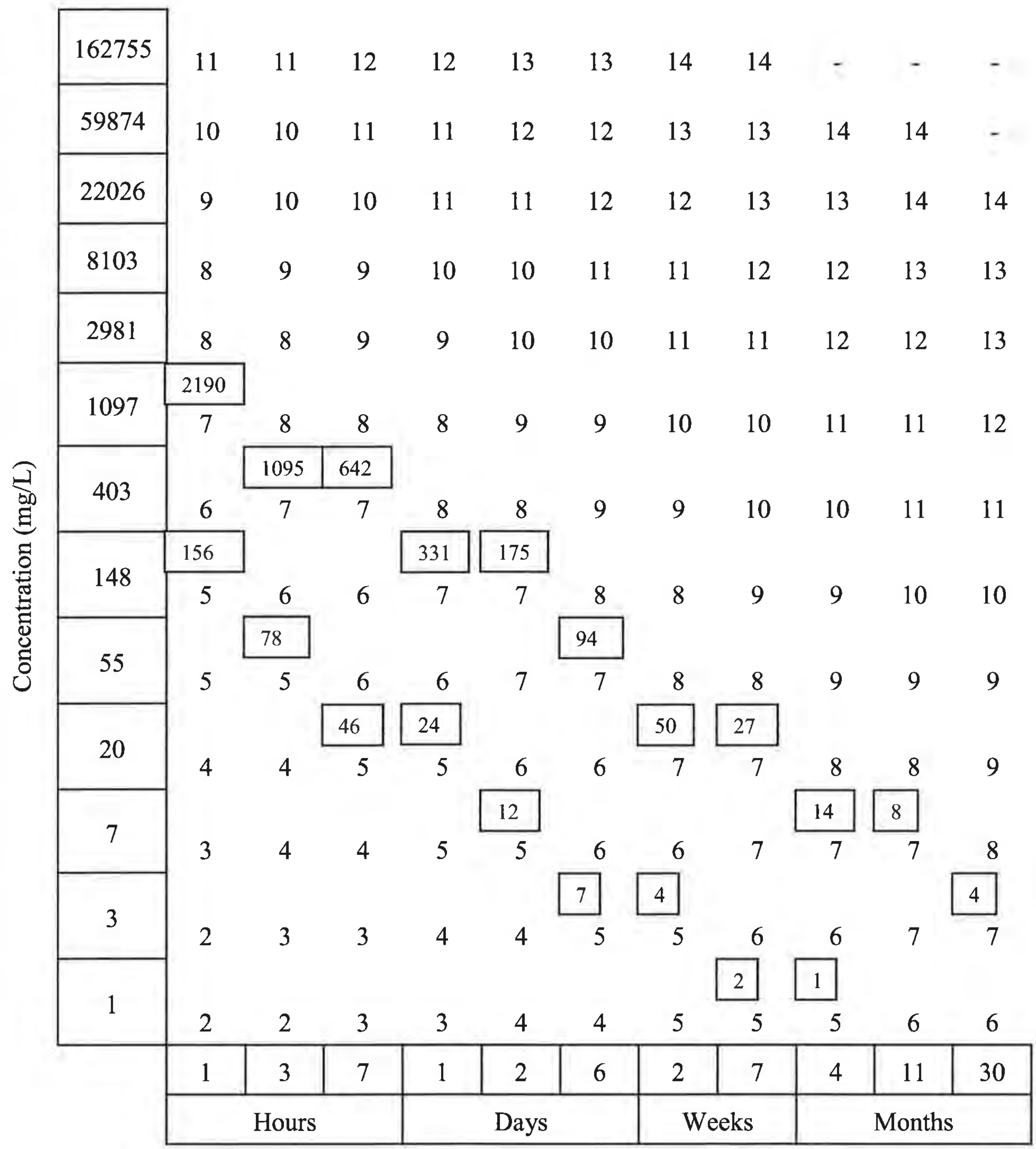


Figure 3 - Severity of ill effect scores for juvenile salmonids. The individual boxes provide the maximum concentration for that SEV. The concentration between 4 and 5 represents the threshold for harassment, and the concentration between 7 and 8 represents the threshold for harm.

Juvenile Salmonids
Average severity of ill effect scores

Concentration (mg/L)	Hours			Days			Weeks		Months		
	1	3	7	1	2	6	2	7	4	11	30
162755	9	10	11	11	12	13	14	14	-	-	-
59874	9	9	10	11	11	12	13	14	14	-	-
22026	8	9	9	10	11	11	12	13	13	14	-
	13119										
8103	7	8	9	9	10	11	11	12	13	13	14
		4448									
2981	6	7	8	9	9	10	11	11	12	13	13
			1931								
1097	6	6	7	8	9	9	10	11	11	12	13
				687							
403	5	6	6	7	8	9	9	10	11	11	12
	197				254						
148	4	5	6	6	7	8	9	9	10	11	11
		67				96					
55	4	4	5	6	6	7	8	8	9	10	11
			29				36				
20	3	4	4	5	6	6	7	8	8	9	10
				10				13			
7	2	3	4	4	5	6	6	7	8	8	9
					4				5		
3	1	2	3	4	4	5	6	6	7	8	8
						1					
1	1	1	2	3	4	4	5	6	6	8	8

Figure 4 - Severity of ill effect scores for eggs and alevins of salmonids. The individual boxes provide the maximum concentration for that SEV. The concentration between 4 and 5 represents the threshold for both harassment and harm to eggs and alevins.

Eggs and Alevins of Salmonids
Average severity of ill effect scores

Concentration (mg/L)	Hours			Days			Weeks		Months		
	1	3	7	1	2	6	2	7	4	11	30
162755	7	9	10	11	12	13	14	-	-	-	-
59874	7	8	9	10	12	13	14	-	-	-	-
22026	7	8	9	10	11	12	13	-	-	-	-
8103	7	8	9	10	11	12	13	14	-	-	-
2981	6	7	8	10	11	12	13	14	-	-	-
1097	6	7	8	9	10	11	12	14	-	-	-
403	6	7	8	9	10	11	12	13	14	-	-
148	5	6	7	9	10	11	12	13	14	-	-
55	5	6	7	8	9	10	12	13	14	-	-
20	5	6	7	8	9	10	11	12	13	-	-
	11										
7	4	5	7	8	9	10	11	12	13	14	-
3	4	5	6	7	8	10	11	12	13	14	-
1	4	5	6	7	8	9	10	11	13	14	-

Figure 5 - Severity of ill effect scores for salmonid habitat. The individual boxes provide the maximum concentration for that SEV. The concentration between 6 and 7 represents the threshold for anticipating adverse effects to bull trout through habitat modifications.

Salmonid Habitat
Average severity of ill effect scores

Concentration (mg/L)											
162755	11	12	12	13	14	-	-	-	-	-	-
59874	10	11	12	12	13	14	-	-	-	-	-
22026	9	10	11	11	12	13	14	14	-	-	-
8103	8	9	10	11	11	12	13	14	14	-	-
2981	8	8	9	10	11	11	12	13	13	14	-
1097	7	7	8	9	10	10	11	12	13	13	14
	$\boxed{885}$										
403	6	7	7	8	9	10	10	11	12	12	13
		$\boxed{345}$	$\boxed{167}$								
148	5	6	6	7	8	9	9	10	11	12	12
				$\boxed{68}$							
55	4	5	6	6	7	8	9	9	10	11	11
					$\boxed{29}$						
20	3	4	5	5	6	7	8	8	9	10	11
						$\boxed{12}$					
7	2	3	4	5	5	6	7	7	8	9	10
							$\boxed{5}$				
3	2	2	3	4	5	5	6	7	8	8	9
								$\boxed{2}$			
1	1	1	2	3	4	4	5	6	7	7	8
	1	3	7	1	2	6	2	7	4	11	30
	Hours			Days			Weeks		Months		

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